POULTRY FEEDS AND FEEDING

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DOMINION EXPERIMENTAL FARMS

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Poultry Feeds and Feeding

By George Robertson and H. S. Gutteridge

It has been the aim in this bulletin to make the subject of feeds and feeding of poultry as simple as possible. While it has seemed advisable to try to familiarize the uninformed reader with the more common scientific terms, this has been done only to such an extent as will permit the reader to study and mix feeds intelligently. Wherever terms that might be unusual to ordinary poultry keepers are used, care has been taken to explain them as simply as possible, so that any person reading the bulletin through should have no trouble in following it.

While sample rations are given for each kind of stock, it must not be supposed that these are given as the only rations or even as the best rations. Each one is typical of rations which are generally used for the purpose under consideration and have proven satisfactory in experimental trials and in actual practice. The make up of a ration should depend to a great extent upon what feeds are available bearing in mind, however, that certain essential requirements must be fulfilled.

A BALANCED RATION

The feeding of poultry is more or less like the feeding of any other live stock, and the ration used must be varied according to the purpose for which it is intended. Normally a poultry ration will be composed of grain feeds (either whole or ground grain and their by-products), feeds of animal origin, mineral feeds, supplementary feeds (vitamins) and water.

These feeds must not only be supplied, but they must be supplied in such quantities and proportions that they will form a ration suited to the purpose for which it is intended. Such a ration is called a balanced ration.

More specifically, a balanced ration is one that contains proteins, carbohydrates, fats, ash (minerals), fibre and the necessary supplementary feeds (vitamins) in the proportions required for the maintenance, activity and production of the animal to which it is fed. In addition it is essential that all of the above nutrients be supplied in such form and variety that proteins of the right type, minerals in proper balance and in readily available form and the vitamins necessary to bring about proper assimilation of these elements are provided. Each of the above mentioned elements of the ration will be considered separately in detail.

Protein.—Protein is the nitrogenous part of the food, and is largely used for growth, the repairing of waste tissue, and for production.

Proteins are not all of equal feeding value. Apart from their chemical composition, which varies considerably in respect to nitrogen and sulphur content, proteins contain certain acids known as amino acids. " Proteins such as gelatin, lacking in the amino acids tyrosine, cystine and tryptophane—are incomplete for all physiological purposes since they cannot supply all the " building stones " necessary for the construction of body proteins. The nutritive value of a protein or mixture of proteins depends upon the presence in its molecules of *all* the essential amino acids, and upon the extent to which their proportions correspond to those existing in the body proteins to which they are to be transformed.* Many proteins are deficient in one or other of the amino acids but one protein may supplement the deficiency of another, consequently it will be appreciated that variety of proteins may be essential for efficiency in a ration. The development and maintenance of muscle tissue, the glandular organs, feathers and eggs are dependent to a large extent upon the assimilation of proteins from the feed.

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* The Newer Knowledge of Nutrition. McCollum, E. V. and Simmonds, N. 4th edition.

Carbohydrates.—All carbohydrates may be converted into fat and stored in various parts of the body or into glycogen and stored in the liver to be used when needed by being changed in the body into glucose. For these reasons they play an important part in maintenance of body weight in fowl under heavy egg production. They are composed mostly of sugars and starches.

Fats.—Fats are very similar to carbohydrates particularly in the respect that they are used mainly for production of heat and body energy. They are stored in large quantities both in the tissues and surrounding the internal organs. Fats are a more highly concentrated source of energy than carbohydrates. Under a condition of insufficiency of both carbohydrates and fats, proteins may be converted into fat for energy production. Carbohydrates and fats cannot be converted to proteins, however, so that a ration deficient in protein, no matter how rich in carbohydrates and fats cannot give good results.

Ash.—Besides the three fore-mentioned elements, ash, which is the term used to designate the mineral compounds, is also of importance, as it enters into practically all functions of the body and particulary into the formation of bones and egg shells. Certain minerals also, notably iron and copper, enter into the normal composition of the blood and are essential in the prevention of anemia. The role of two minerals, calcium and phosphorus, particularly in the nourishment of the living cell and in bone formation, makes them of real importance in nutrition.

In the feeding of poultry, optimum quantities of minerals have not yet been determined. It is definitely, known, however, that cereal grains which make up by far the greatest portion of the poultry ration are deficient in minerals for both growth and egg production. Thus the necessity of making provision for mineral feeds in addition to the regular cereal ration becomes obvious. Since, as mentioned above, requirements for optimum condition are not known it is necessary to supply minerals in excess, the proper balance then being maintained through elimination of surplus by the kidneys. It has also been shown that a proper balance between minerals is necessary particularly in the ratio of calcium to phosphorus for bone formation.

Fibre.—Fibre is made up chiefly of the woody parts of plants. Unlike ruminants and most larger animals, poultry are unable to digest fibre in any quantities. The absence of cellulose splitting enzymes together with the rapidity of digestion of poultry make it unlikely that fibre digestion can be carried on. The value of fibre as a nutrient in poultry rations may therefore, for all practical purposes, be ignored. It does exert, however, a decided influence upon the bulk of the ration and thus on the amount of other nutrients consumed. In addition it has been found in some instances that a ration extremely low in fibre caused the picking up of straw, dried grass or similar substances, in order to increase the intake of fibre with resultant wholesale crop impaction.

Vitamins.—Vitamins, or accessory food factors as they are sometimes called, are substances preponderantly if not entirely of vegetable origin which are essential to life and specifically to certain functions of the animal body depending upon the particular vitamin under consideration. Until recently these substances have defied isolation in the pure form but well substantiated claims to isolation of pure vitamin D have been made during the past two years (1931-32). Those vitamins so far recognized have been classified and given definite nomenclature. While they are not all of importance in poultry nutrition they will be considered briefly.

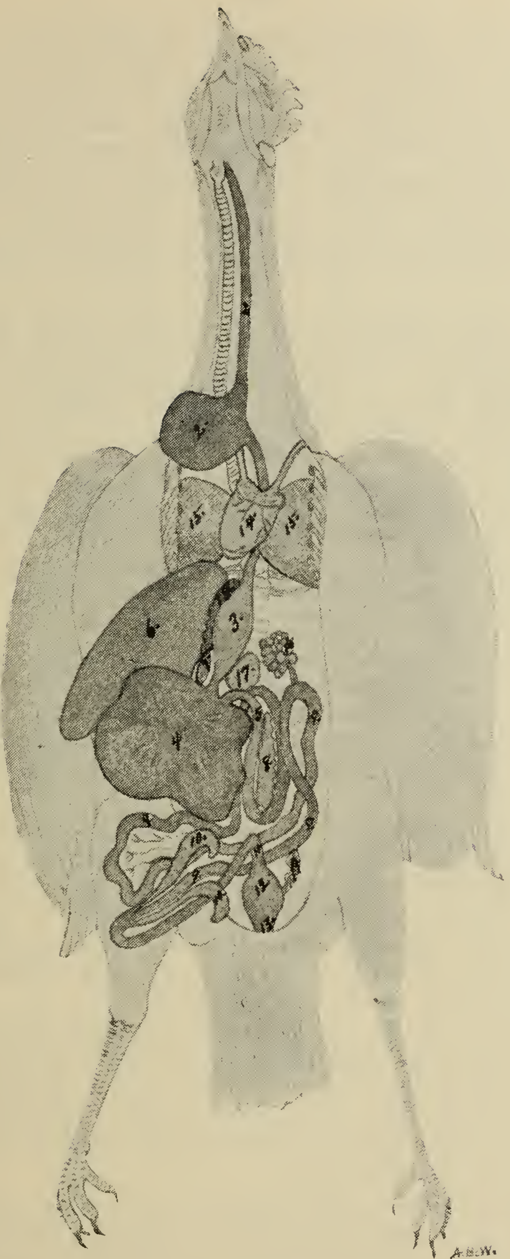

FIG. 1.—Description of plate showing digestive organs of fowl.

The food after entering the mouth passes into the gullet (No. 1), thence into a sack-like enlargement of the former, called the crop (No. 2), from where it passes into the true stomach (No. 3), where it is mixed with the digestive juices, after which it passes into the gizzard (No. 4), where it is ground fine; then into the duodenum (No. 5) (first portion of the small bowel), where a secretion from the liver (No. 6) called bile which is stored in the gall bladder (No. 7) and also the juices from the pancreas (No. 8) are mixed with it; then passes through the long intestine (No. 9) where absorption takes place and into the caeca (No. 10), after which the residue is passed on into the rectum (No. 11) and through a continuation of the rectum called the cloaca (No. 12) (junction of the intestine and the oviduct) to be voided at the vent (No. 13).

Other organs shown are: (No. 14) heart, (No. 15) lungs, (No. 16) ovary, (No. 17) spleen, (No. 18) margin where left lobe of liver has been removed, (No. 19) oviduct.

Original drawing by Dr. A. B. Wickware.

Vitamin A.—This vitamin is classed as a " fat soluble " and is therefore found only in fatty substances. Its presence in the ration is essential for normal growth. A disease of the eye, known as xeropthalmia, is brought about under conditions of deficiency of this vitamin. Also susceptibility to infection is greatly increased in its absence. A complete absence of vitamin A in young chicks leads to cessation of growth, lack of control and finally death. Although evidence is not completely definite, a disease common in poultry known as visceral gout is attributed to lack or insufficiency of vitamin A. It is known that the requirements of poultry for vitamin A are higher than those of most other animals.

Vitamin D.—This vitamin is also fat soluble. Its presence is essential to proper bone formation and the most important symptom, in its absence, is a severe condition of rickets. As with vitamin A, poultry have a very high requirement for the vitamin, and its absence has been shown to produce rickets, diminution of growth, production of soft egg shells and low hatchability. Vitamin D occurs in very few substances in sufficient concentration to be useful as a food supplementary to poultry rations. In the presence of direct sunlight, however, growth may be normal and bone formation perfect even though substances containing this vitamin are lacking in the ration. It is considered that the ultra violet rays of the sun activate a substance found in the skin with the resultant production of vitamin D. This source of vitamin D (sunlight) is of great importance in poultry nutrition.

Vitamin B.—This vitamin is water soluble and while originally being considered as one unit it has now been shown to consist of at least five separate and distinct principles. Since the status of these entities has not been definitely established they will not be considered here with the exception of the two fractions, B_1 and B_2, which have been shown to have a definite effect upon poultry nutrition.

B_1, known as the anti-neuritic factor, is essential for growth and its absence causes a very typical nervous disease in fowl, known as polyneuritis. The symptoms of this condition are typical and unmistakable. When this vitamin is supplied cure is effected in a remarkably quick time.

B_2, known as the anti-dermatitis vitamin, when absent from the ration causes ruffling and loss of feathers, inflammation and scabbing at the base of the beak and death if the vitamin is not supplied.

Both vitamins B_1 and B_2 are generally associated in the same foodstuffs and since cereal grains and particularly certain parts of the grains (embryo) are comparatively rich in these vitamins, they are not considered at the present time to be of great concern in poultry feeding due to the high intake of cereals by poultry. Whether this idea is completely in accord with fact or not must await further research for verification.

Vitamin C.—Since chickens are apparently not subject to scurvy, which is caused by a deficiency of this vitamin, it is considered to be of no importance in poultry feeding. As a matter of fact in experimental tests fowl have subsisted normally upon a scorbutic diet, that is, one free from vitamin C.

Vitamin E.—This vitamin (anti-sterility vitamin) influences fertility and when absent may remove the possibility of reproduction. However, it has been shown to exist in large quantities in the cereal grains, particularly in the germ oil, in greenfeed and flesh, consequently it is probably of no particular significance in poultry feeding.

In considering the role of vitamins in poultry feeding it is significant to know that vitamins A, B, C, and D are all found in poultry products, viz, eggs and poultry meat.

Vitamin Content of Feeds

A great mass of data has accumulated, particularly in the last decade, showing the value of numerous feeding stuffs as sources of the different vitamins. It is of considerable advantage to the poultryman to be familiar with the value of the different feeds at his disposal in this respect as it permits him to choose the ingredients of his ration with reasonable certainty as to their sufficiency in vitamins. The following table is given and represents the most recent compilation available (1932). In the table, o indicates that the vitamin was not detected; x, that the material contains the vitamin; xx, that it is a good source of the vitamin; xxx, that it is a rich source of the vitamin. Under the column headed B the values are those for the water soluble B vitamin complex. Where separate determinations have been made for B_1 and B_2 the values are indicated under the columns provided. With the exception only of sardine oil, the values listed were procured from "Vitamins; a survey of present knowledge," a monograph of the Medical Research Council under the Special Report Series No. 167.

TABLE 1—DISTRIBUTION OF VITAMINS IN FOODSTUFFS

Foodstuffs	A	D	E	B_1	B_2	B	C
Cereals							
Wheat (whole grain)		...	x	xx	x	...	o
Wheat bran	x	...	...	xx	xx	...	o
Wheat middlings	...	...	...	xx	x	...	o
Wheat flour	o	...	...	o	o	...	o
Wheat flour (whole meal)	o to x	...	...	x	x	...	o
Wheat embryo (germ)	xx	...	xxx	xxx	xx	...	o
Barley (whole grain)	x	...	...	xx	...	x	o
Barley (hulled)	...	...	...	xx	...	...	o
Barley (sprouted)	x	...	...	...	...	...	x
Oats (whole grain)	o to x	o	x	x	...	x	o
Oat meal	o to x	...	...	...	...	x	o
Oats (sprouted)	...	...	...	...	...	...	x
Corn yellow (whole grain)	xx	o to x	x	xx	x	...	o
Corn yellow (gluten)	xx	...	...	o	...	...	o
Corn yellow (endosperm)	xx	...	...	o	o	...	o
Corn yellow (embryo)	o to x	...	xxx	xxx	x	...	o
Rice (whole grain)	x	o	...	xx	x	...	...
Rice polished	o	...	o to x	o	o	...	o
Rice bran	...	...	...	xx	...	...	o
Rice polishings	x	...	...	xxx	...	...	...
Rice polishings (ether extract)	...	...	xxx	...	...	...	...
Rice polishings (alcohol extract)	...	...	...	xxx	x	...	...
Rice embryo (germ)	...	...	...	xxx	...	...	o
Rice wild	x	...	...	...	...	xx	o
Rye (whole grain)	x	...	...	xx	...	...	o
Rye embryo	xx	x	...	...	...	...	o
Buckwheat	...	...	...	x	...	...	...
Malt green	x	...	...	...	...	...	xx
Malt kilned	...	...	...	x	...	x	o
Millet	x	...	...	xx	x	...	o
Corn white (whole grain)	o	...	...	xx	x	...	o
Corn white (endosperm)	o	...	...	o	o	...	o
Corn white (embryo)	o	...	...	xxx	x	...	o
Vegetable, Fruit, Etc.							
Peas, dried	x	...	...	xx	xx	...	x
Peas, green	xx	...	...	...	...	xx	xxx
Peas, green, canned	xx	...	...	...	...	xx	xx
Peas, yellow	xx	...	...	...	...	...	...
Soy beans	x	...	x	x	x	x	o
Peanut	x	...	x	xx	...	x	...
Cotton seed	x	...	...	...	...	...	x
Cotton seed meal	x	...	...	...	...	...	...
Linseed	xx	...	...	...	...	...	x

TABLE 1—DISTRIBUTION OF VITAMINS IN FOODSTUFFS—*Continued*

Foodstuffs	A	D	E	B_1	B_2	B	C
VEGETABLE, FRUIT, ETC. *Concluded*							
Linseed cake	x	....	....	....	....	....	....
Beet, leaf and stem	xx	....	....	....	....	x	....
Beet, root	o to x	....	....	....	....	x	x
Cabbage, green, fresh	xx	....	x	xx	xx	....	xxx
Cabbage, green, dried	x	....	....	xx	xx	....	x
Cabbage, cooked	x	....	....	....	....	....	x
Cabbage, canned	....	....	....	....	....	....	xx
Cabbage, whole head	x	....	....	....	....	....	....
Carrot, young, raw	x	....	....	xx	x	....	xx
Carrot, young, cooked	....	....	....	....	....	....	x
Carrot, young, canned	....	....	....	....	....	....	o
Carrot, old, raw	xx	....	....	xx	x	....	x
Carrot, dried	....	....	....	xx	x	....	x
Clover	xx	....	....	....	....	xx	....
Dandelion	xx	....	....	....	....	xx	x
Kale	xx	....	xx	....	....	....	....
Lettuce, green	xx	....	xxx	xx	x	....	xxx
Lettuce, dried	....	....	xxx	xx	x	....	o
Alfalfa, fresh	....	....	xxx	....	....	xx	....
Alfalfa, dry	xx	....	xxx	....	....	xx	....
Mangel, root	o to x	....	....	....	....	....	x
Mangel, leaf	....	....	....	....	....	....	xxx
Parsnip	o to x	....	....	....	....	xx	....
Potato, raw	x	....	....	xx	x	....	xx to xxx
Potato, cooked	x	....	....	....	....	....	x to xx
Potato, peel	....	....	....	xx	....	....	....
Rape, leaf	....	....	....	x	xx	....	....
Spinach, raw	xx	o to x	....	x	xx	....	xxx
Spinach, dried	xx	....	....	x	xx	....	....
Spinach, cooked	xx	....	....	x	xx	....	x to xx
Spinach, canned	xx	....	....	....	....	....	x to xx
Swede (turnip)	x	....	....	....	....	x	....
Timothy, grass	....	....	....	....	....	x	....
Turnip, root	o to x	....	....	x	x	....	xx
Turnip, leaf	xx	....	....	....	xx	xx	xx
Apple	x	....	....	x	x	x	x to xx
Grape fruit	x	....	....	....	....	x	xxx
Lemon	x	....	....	....	....	x	xxx
Orange pulp	....	....	....	xx	x	x	....
Orange juice	x	....	x	....	....	x	xxx
Tomato ripe	xx	....	....	x	x	xx	xxx
Tomato green	x	....	....	....	....	xx	....
Tomato canned	xx	....	....	....	....	xx	xx to xxx
Tomato dried	....	....	....	....	....	xx	xx
MEAT AND FISH							
Beef	....	....	xx	xx	xx	....	o to x
Blood meal	o	o	....	....	....	....	....
Chicken liver	....	xx	....	....	....	....	x
Fish, fat, muscle	x	x	....	....	....	....	....
Fish liver	xxx	xxx	....	....	....	....	....
Fish meal	xx	xx	....	....	....	....	....
Liver extract	....	....	....	xx	xxx	....	....
Meat meal	o	o	....	....	....	....	....
Beef liver	xxx	....	xx	xx	xxx	....	....
Pig liver	xx to xxx	x	xx	....	....	xx	xx
Poultry	o to x	....	....	....	....	....	....
Eggs, hen, fresh	xx	xx	....	x	x to xx	....	....
Eggs, dried	xx	x	....	....	....	....	o
Egg yolk	xx	xxx	xx	xx	x	....	o
Egg white	o	o	....	....	xx	....	o
MILK PRODUCTS							
Buttermilk	x	....	....	....	....	x	o to x
Cheese	xx	....	....	o	x	....	....
Cow's milk, whole	x	o to x	x	x	xx	....	x
Cow's milk, skimmed	o to x	....	....	....	....	....	o to x
Cow's milk, skimmed, dried	o to x	....	o	....	....	x	o to x

TABLE 1—DISTRIBUTION OF VITAMINS IN FOODSTUFFS—*Concluded*

Foodstuffs	A	D	E	B_1	B_2	B	C
MISCELLANEOUS							
Seaweed........	xx	....	....	....	....	....	....
Yeast, brewers........	o to x	o	o to x	xxx	xxx	....	o
Yeast, brewers, dried........	....	....	....	xxx	xxx	....	o
Yeast (marmite)........	....	....	....	xxx	xxx	....	o
OILS AND FATS							
Butter fat (pasture)........	xx	xx	xx	....	....	....	o
Cream........	xx	....	....	....	....	....	....
Cod oil, body........	x	....	....	....	....	....	....
Herring oil, body........	xx	....	....	....	....	....	....
Salmon oil, body........	x to xx	....	....	....	....	....	....
*Sardine oil, body........	xxx	xxx	....	....	....	....	....
Cod liver oil........	xxx	xxx	o to x	....	....	....	....
Halibut liver oil........	xxx	....	....	....	....	....	....
Salmon liver oil........	xxx	xx	....	....	....	....	....
Poultry fat........	x	....	....	....	....	....	....
Wheat germ oil........	x	....	xxx	....	....	....	....

* Derived from a consideration of data reported as follows:—

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NELSON, E. M. and MANNING, J. R.—Vitamins A and D in fish oils.—Ind. and Engineering Chem. 22; 12, 1361, 1930.

It should be noted that dry alfalfa as given in the above table represents a well-cured hay. Alfalfa hay bleached is a very poor source of vitamin, as indicated in the vitamin tables of Henry and Morrison in " Feeds and Feeding."

It should also be noted that the reference for sardine oil also covers what is known as pilchard oil, a product derived from the mature sardine and proven to be a rich source of vitamins A and D.

Nutrients in Feeds

The principal nutrients, viz. proteins, carbohydrates, fats, ash and fibre have been discussed separately in preceding paragraphs. In order that our knowledge of these nutrients and of their respective functions in the animal body may be put to practical use it is necessary to know their relative occurrence in the feeding stuffs which we commonly give to poultry. A table of nutrient values is given herewith covering a great many of the feeds commonly used at the present time. In many instances these figures represent more than one thousand individual analyses, consequently they may be taken as a fair average for the feeds considered. The caution must be made, however, that variation from sample to sample, of the same feed covers a wide range, consequently the only really accurate way of knowing the nutrient content of any sample is by a chemical analysis of that sample. For example it was found that in three hundred cars of wheat middlings analysed by a large commercial firm the range of protein was from 13·02 per cent to 19·06 per cent and of one hundred consecutive cars in each of the months of February, July and November, only four, eleven and forty seven cars respectively equalled or exceeded the Henry and Morrison average (17·4 per cent).* Under such conditions average analyses as shown in the following table give only an approximation and are most useful to show the comparative merits of the different feeds.

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* Rolf, A. F. Proceedings of World's Poultry Congress, Ottawa, 1927.

TABLE 2—AVERAGE PERCENTAGE COMPOSITION OF FEEDING STUFFS

Feeding stuffs	Water	Ash	Crude protein	Carbohydrates		Fat
				Fibre	N-free extract	
CEREALS						
Barley, common	9·3	2·7	11·5	4·6	69·8	2·1
Barley, hulless	9·3	2·8	10·8	2·9	71·6	2·6
Barley feed (high grade)	10·2	4·2	12·8	8·6	60·6	3·6
Buckwheat	12·1	2·1	10·8	10·3	62·2	2·5
Buckwheat flour	12·8	1·1	7·9	0·6	76·1	1·5
Buckwheat middlings	12·0	4·8	28·3	4·8	42·7	7·4
Corn, dent, grade No. 1	12·0	1·5	9·9	2·0	69·7	4·9
Corn, dent, grade No. 3	16·5	1·4	9·4	1·9	66·1	4·7
Corn flint	12·2	1·5	10·4	1·5	69·4	5·0
Corn bran	10·0	2·4	9·7	9·8	62·4	5·7
Corn germ meal	8·9	2·7	22·6	9·0	46·0	10·8
Corn gluten meal	9·4	1·3	44·4	3·1	38·9	2·9
Cottonseed meal	7·8	6·6	39·8	10·1	27·4	8·3
Flax seed	9·2	4·3	22·6	7·1	23·2	33·7
Hominy feed	10·1	2·6	10·6	4·4	64·3	8·0
Kafir grain	11·8	1·7	11·1	2·3	70·1	3·0
Linseed meal, new process	9·6	5·6	36·9	8·7	36·3	2·9
Malt	5·8	2·9	18·0	9·0	60·6	3·7
Millet seed	10·8	3·6	12·1	8·4	61·0	4·1
Milo grain	10·7	2·8	10·7	2·4	70·5	2·9
Molasses (cane)	25·7	6·1	3·2	....	65·0	....
Oats	9·2	3·5	12·4	10·9	59·6	4·4
Oats, light weight	8·7	4·5	12·3	15·4	54·4	4·7
Oat kernel	6·9	2·2	14·3	1·4	67·1	8·1
Oat meal (rolled oats)	7·9	2·0	16·0	1·5	66·1	6·5
Oat middlings	6·9	3·2	16·3	4·3	62·5	6·8
Oat shorts	6·1	4·1	16·1	9·3	58·5	5·9
Pea, field	9·2	3·4	22·9	5·6	57·8	1·1
Pea, meal	10·9	3·6	23·8	4·6	55·7	1·4
Peanut kernel	5·3	2·3	30·5	2·5	11·7	47·7
Peanut oil meal	6·6	4·8	44·8	7·6	26·0	10·2
Potato flour	10·6	2·4	2·7	2·2	81·3	0·8
Rice, rough (with hull)	9·6	4·9	7·6	9·3	66·7	1·9
Rice bran	10·1	9·7	12·1	12·4	44·3	11·4
Rice polish	10·0	4·8	11·9	1·9	62·3	9·1
Rye	9·4	2·0	11·8	1·8	73·2	1·8
Rye middlings	11·4	3·7	15·7	4·6	61·2	3·4
Sorghum grain	12·7	1·9	9·2	2·0	70·8	3·4
Soy bean seed	9·9	5·3	36·5	4·3	26·5	17·5
Soy bean oil meal	10·5	4·9	43·2	5·3	29·5	6·6
Sunflower seed (with hull)	4·5	3·8	27·7	6·3	16·3	41·4
Wheat (all analyses)	10·2	1·9	12·4	2·2	71·2	2·1
Wheat durum	10·4	1·8	14·1	2·6	68·6	2·5
Wheat bran	10·4	6·3	15·7	10·2	52·6	4·8
Wheat flour (patent)	12·3	0·5	10·9	0·4	74·6	1·3
Red dog flour	11·1	2·5	16·8	2·2	63·3	4·1
Wheat middlings (flour)	10·7	3·7	17·8	4·7	58·1	5·0
Wheat middlings standard (shorts)	10·5	4·4	17·4	6·0	56·8	4·9
Wheat screenings	10·2	3·9	13·3	7·4	61·1	4·1
Bread	33·8	1·5	7·9	0·7	55·4	0·7
Beet pulp, dried	8·2	3·5	8·9	18·9	59·6	0·9
Brewers grains, dried	7·5	3·5	26·5	14·6	41·0	6·9
Brewers grains, wet	75·9	1·0	5·7	3·6	12·1	1·7
GREENFEEDS, VEGETABLES, ETC.						
Alfalfa (fresh)	74·7	2·4	4·5	7·0	10·4	1·0
Alfalfa hay	8·6	8·6	14·9	28·3	37·3	2·3
Alfalfa hay (before bloom)	6·2	10·0	22·0	20·5	37·1	4·2
Alfalfa leaves	6·6	13·6	22·5	12·7	41·2	3·4
Alfalfa meal	8·8	9·0	14·3	30·1	35·8	2·0
Clover red (fresh)	73·8	2·1	4·1	7·3	11·7	1·0
Clover hay (red)	12·9	7·1	12·8	25·5	38·7	3·1
Clover hay (red, before bloom)	10·4	7·2	18·7	18·3	41·8	3·6
Clover meal	8·5	7·2	13·7	25·9	42·4	2·3
Timothy (fresh)	62·5	2·2	3·1	11·7	19·3	1·2
Timothy hay	11·6	4·9	6·2	29·8	45·0	2·5
Beet, common	87·0	1·5	1·6	0·9	8·9	0·1
Carrot	88·3	1·2	1·2	1·1	8·0	0·2

TABLE 2—AVERAGE PERCENTAGE COMPOSITION OF FEEDING STUFFS—*Concluded*

Feeding stuffs	Water	Ash	Crude protein	Carbohydrates		Fat
				Fibre	N-free extract	
GREENFEEDS, VEGETABLES, ETC.—*Con.*						
Mangel	90·6	1·0	1·4	0·8	6·1	0·1
Potato	78·8	1·1	2·2	0·4	17·4	0·1
Turnip	90·5	0·9	1·4	1·1	5·9	0·2
Apple	81·8	0·4	0·5	1·3	15·6	0·4
Cabbage	91·1	0·8	2·2	0·9	4·7	0·3
Cabbage, outer leaves	85·9	3·1	2·7	2·8	5·1	0·4
Kale	88·7	1·9	2·4	1·5	5·0	0·5
Rape	83·3	2·2	2·9	2·6	8·4	0·6
Corn silage	73·7	1·7	2·1	6·3	15·4	0·8
Clover silage	75·6	2·2	3·9	6·6	10·4	1·3
FEEDS OF ANIMAL ORIGIN						
Buttermilk	90·6	0·7	3·6	....	5·0	0·1
Buttermilk, dried	4·5	8·1	34·6	....	50·9	1·9
Buttermilk, semi-solid	65·0	2·7	13·4	....	15·9	3·0
Skim milk	90·1	0·7	3·8	....	5·2	0·2
Skim milk, dried	4·6	8·1	37·3	....	49·3	1·3
Whey	93·4	0·7	0·8	....	4·8	0·3
Milk albumen (dried)	6·2	21·5	58·9	....	1·5	3·6
Blood meal	9·7	3·3	82·3	....	3·8	0·9
Bone, green cut	30·4	21·1	19·7	....	3·8	25·0
Bone meal	7·3	61·7	24·3	....	3·6	3·1
Fish meal	10·5	28·1	51·4	....	....	8·3
Meat and bone meal	6·0	36·8	39·8	2·1	4·1	11·2
Meat meal (high grade)	6·9	17·2	59·6	....	....	11·4
Tankage (50-60% protein)	9·0	18·4	51·7	6·6	3·9	10·4
Eggs	65·2	0·7	11·9	....	....	10·1
Poultry meat (edible portion)	68·4	1·1	21·9	....	....	8·9

Analyses from Feeds and Feeding, Henry and Morrison, 19th edition.

Digestible Nutrients

It is a well known fact that feeds of closely identical nutrient composition are not necessarily of equal feeding quality. The animal body is able to make use of almost all the nutrients of one feed and of very little of another in spite of this similarity in chemical analysis. In other words a large percentage of the nutrients of one food are digestible whereas much of those of the other are eliminated with the faeces. There is only one way to accurately determine the availability of nutrients in any food namely by a digestibility trial wherein the amounts and analyses of foods given are checked against the amounts and analyses of excrement voided, the difference, which has been assimilated into the body, being the amount digested for that particular food. These results are usually given as " coefficients of digestibility " which represent the percentage of a food or a nutrient which is digestible. Digestibility trials with poultry are complicated owing to the fact that the excrement of the kidneys and of the digestive tract are voided together and cannot readily be separated. Consequently the digestibility of very few feeds by poultry has been determined. The table given herewith shows the coefficient of digestibility of protein, carbohydrates and fats of thirty-six feeds for poultry. Since as previously stated, fibre is practically indigestible to poultry, the coefficients for fibre are not given. Since the analyses of total nutrients for these feeds are given in table (2) the actual digestible nutrients for the feed may be obtained from this table. For example, from table (2) barley contains 11·5 per cent crude protein; from table (3) it is seen that the protein of barley is 72·0 per cent digestible; therefore 72·0 per cent of 11·5 per cent or 8·28 pounds of protein are digested in every one hundred pounds of barley. Although digestibility coefficients are available for many more feeds for ruminants and other farm animals, they are not given here as the ability to digest nutrients varies greatly for poultry as against other animals. Consequently such coefficients are not applicable to poultry feeds.

TABLE 3—COEFFICIENTS OF DIGESTIBILITY OF FEEDS BY POULTRY

Feeding stuff	Protein	Carbohydrates	Fat
CEREALS			
Barley	72·0	82·1	58·1
Buckwheat	61·2	83·9	86·3
Corn	74·9	90·1	85·1
Corn meal	71·8	91·9	91·6
Cottonseed meal	76·1	85·7	86·2
Cow peas	48·4	86·2	87·9
Kafir corn	66·8	91·7	78·1
Millet	76·1	87·0	77·9
Milo	83·3	91·5	77·5
Oats	74·1	69·3	81·7
Oat groats	76·7	90·5	88·6
Ground peanuts	80·3	84·2	78·4
Peas	88·1	87·1	81·2
Rice (whole with hull)	74·2	83·8	72·2
Rice polish	80·9	89·3	94·8
Rice (brown)	84·1	98·1	87·9
Rice bran	57·9	52·3	87·1
Rye	65·3	86·0	31·4
Sorghum seed	16·0	88·0	84·1
Soy bean (whole)	69·9	76·4	93·0
Soy bean oil meal (fat extracted)	83·3	83·2	81·4
Wheat	74·0	88·9	47·1
Wheat bran	59·9	54·1	50·0
Wheat shorts	69·2	71·0	85·2
Wheat middlings	50·0	49·7	52·6
Wheat middlings (8·5% fibre)	76·2	59·6	52·6
VEGETABLE			
Alfalfa leaf meal	99·7	....	....
Alfalfa meal	63·4	34·4	21·8
Potatoes	46·9	84·5	....
Sweet potatoes	....	77·3	24·7
ANIMAL PRODUCTS			
Blood meal	91·4	47·7	46·3
Buttermilk	81·6	81·1	78·6
Fish meal	90·7	15·4	95·7
Meat and Bone meal	91·0	....	89·5
Bone meal	83·5	79·3	95·8
Tankage	85·3	43·5	95·9

The above analyses are taken from "Digestibility and production coefficients of poultry feeds." Fraps, G. S., Texas Agr. Exp. Station, Bull. 372.

The Nutritive Ratio

As the term nutritive ratio will be used frequently in this bulletin, it will be necessary to have a clear understanding of its meaning.

The nutritive ratio is the ratio which exists between the protein in a given feed and the carbohydrates and fats. For example, wheat contains 12·4 protein, 71·2 carbohydrates, 2·1 fat. The fat being much more concentrated, to bring it to the same value as the carbohydrates, it must be multiplied by 2·25. Therefore, to find the nutritive ratio of wheat, multiply the fat, 2·1, by 2·25, add the carbohydrates 71·2, and divide by the protein 12·4, which gives 6·1 or, in other words, for every one part of protein there are 6·1 parts of carbohydrates, so that 1:6·1 is the nutritive ratio of wheat.

In referring to rations using the terms "narrow" and "wide," we refer to the amount of protein in comparison to the combined amount of carbohydrates and fat. These are relative terms, and are in no way fixed. Where the difference between the percentage of protein and carbohydrates is not large, the ration is said to be narrow, and where the difference is great the ration is said to be wide.

A ration that is more or less generally accepted as suitable may be conveniently used with which to compare other rations; for instance, a suitable chick ration would have a nutritive ratio of about 1:3·0 to 1:4·5. The feathering period calls for a ration rather narrower than the ordinary growing period. The same applies to mature fowl: a maintenance ration would have a nutritive ratio of from 1:6 to 1:6·5, and a fattening ration may be even a little wider, but when a flock is laying heavily, the ration should be narrower, about 1:4 to 1:5, and during moulting even narrower still, about 1:3·5.

It will be readily seen from the foregoing that, in compounding rations, it is advisable to consider the object for which the ration is intended. It is not meant by this carefully to weigh out a given quantity of each variety of feed each day, but it is advisable so to feed that the fowl will be able to get enough of each food element to satisfy the demands that are being made on its system without having to consume far more of other elements than it can properly make use of. For instance, it is impossible to feed a fowl an exclusive corn diet and expect it to lay well or to come through the moult in good condition. To get the amount of protein that it requires, it will be necessary for it to consume far more carbohydrates than it needs; the result will be that the overplus of carbohydrates will be stored as fat, and the fowl will get into such a condition that it will be useless for anything except market purposes.

On the other hand, it is not advisable to use a larger amount of protein than is required, as it is the most expensive element and, consequently, an overplus of protein would unnecessarily increase the cost of the ration.

The nutritive ratio, however, must be considered only as a rough measure of the balance between the protein and carbohydrate-fat portions of the ration and in no way takes the place of the delicate balance of nutrients which may be attained when chemical analyses and digestibility coefficients are intelligently considered in compounding a ration.

GRAIN FOODS AND THEIR BY-PRODUCTS

The most commonly used grain feeds for poultry feeding are wheat, corn, oats and barley and their by-products. Other grains such as buckwheat, rye, rice, millet, peas, sunflower seeds and some others are used to a lesser extent for special purposes or in areas in which they are grown extensively. The more important grains will be considered individually as to their relative merits with particular reference to their suitability for poultry rations.

Wheat

Wheat is the most used grain in poultry feeding in Canada, due partly to its mass production in this country and to its very desirable nutrient characteristics. For example, no cereal grain contains proteins superior to wheat, its proteins being slightly more efficient for promoting growth than are equivalent amounts of protein from milk or eggs.* Wheat, in common with other cereals under discussion, while containing a large variety of minerals, does not contain them in sufficient concentration to support normal nutrition in most animals.

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* The Newer Knowledge of Nutrition. McCollum, E. V. and Simmonds, N. 4th edition.

The grain itself is exceedingly palatable to poultry. It has no hull, which, owing to poor digestion of fibre by poultry, is in its favour. It is also well supplied with vitamins, being exceeded in this respect by yellow corn only. Unfortunately, the digestibility of wheat and its by-products is noticeably lower than is that of many other grains. The lower grades usually make excellent feed; in fact, shrunken wheat is considerably richer in protein than the higher-grade wheats, but, when buying it, precaution must be taken to see that it is perfectly sweet, as musty or fermented feeds are always dangerous to use.

By-products of Wheat.—The by-products of wheat are extensively used, and provide some of the best foods for the feeding of all kinds of poultry.

Wheat Bran.—Bran is composed of the coarser outer coating of wheat, and is valuable in the making of mashes, not only on account of its nutritive qualities, but for its effect in supplying bulk with other feeds which, used alone, would make a mash that would be too sticky. It is also relatively high in protein and minerals.

Shorts, Middlings.—For some years the terms shorts and middlings were used indiscriminately and meant anything from reground bran with a little mill sweepings thrown in, to middlings proper, which is a high-class feed more closely resembling low-grade flour. Fortunately, under the amended "Feeding Stuffs Act" a standard is set for each, so that a purchaser knows when he orders either one or the other just what he may expect.

Shorts consist of fine particles of bran, germ and a small proportion of the floury parts of the grain. It is a valuable feed but as it does not contain as much flour as middlings is not so suitable for mixing with bran.

Middlings have less crude fibre, are richer in nutrients than shorts, and give more "body" to a mash. Either middlings or shorts is the foundation of most Canadian mashes. In some localities, it is impossible to get a good grade of middlings, in which case dependency had better be placed on "Red Dog" or low-grade flour.

Low-grade Flour.—Low-grade flour is not only a nutritious feed, but it is especially valuable in giving the proper consistency to a mash.

Wheat-germ.—Wheat-germ is the germ part of the wheat which is removed in milling. It is flakey in appearance and on account of the low fibre content and to the fact that it is rich in vitamins it is a very valuable addition to the ration. Its vitamin content has resulted in increasingly wide use in human nutrition. It is the best source of vitamins among the cereal grains or by-products, containing vitamins, A, E, B, and B_2 in large quantities.

Stale Bread.—Stale bread is a very palatable feed, and is of special value in the feeding of young stock.

Buckwheat Screenings.—Buckwheat screenings, so called, are a by-product from the elevators. They consist of approximately 50 per cent small or broken wheat, 40 per cent wild buckwheat, 2·5 per cent light oats, 1 per cent flax seed, and 6·5 per cent weed seeds, chaff, and other refuse. It is a valuable feed, and particularly for fattening purposes may be used to advantage. However, on account of spreading noxious weeds it is advisable to either grind all screenings or to cook them thoroughly before feeding. (See report of Poultry Division for 1914.)

Standard Re-cleaned Screenings.—When during the war it was decided that screenings would of necessity have to be largely substituted for the milling grades of wheat in the feeding of poultry, a definite standard was set on which screenings would be sold. This grade which was named Standard Re-cleaned Screenings, consists of approximately 52·7 per cent small and broken wheat, 23·2 per cent wild buckwheat, 2·3 per cent flax seed, 9·5 per cent oats, 12·3 per cent black seeds, straw and other refuse.

Corn

Corn has never been fed in Canada as freely as in the United States. This is no doubt chiefly due to the fact that corn is not produced here to the same extent.

Corn makes an excellent poultry feed and is very palatable. Owing to its fattening tendencies it is a valuable cold weather feed and is usually fed more heavily in the winter period. The most important differentiation between corn and most cereal grains is due to the fact that it is a good source of vitamin A whereas most other grains are relatively poor in this vitamin. White corn is devoid of this vitamin.

Corn heats very readily, and unless it is kiln-dried, it is very difficult to keep it from heating in warm weather. Care should be taken to see that it is perfectly sweet, before feeding. During recent years barley has been substituted for corn in poultry feeding to quite an extent.

Corn Meal.—Most of the mashes used contain more or less corn meal, and what was said with reference to the precautions necessary to avoid the use of tainted corn applies even more to corn meal or corn chop.

Gluten Meal.—Gluten meal is very rich in both protein and fat, and is a valuable addition to the mash when used in conjunction with other feeds. In buying feeds of this kind it is always best to insist on a guaranteed analysis being supplied, and in gluten meal especially is this necessary as there are frequently great differences in feeding value.

Gluten Feed.—Gluten feed should not be confused with gluten meal. It is a combination of gluten meal and other by-products such as bran, and is not nearly so rich in nutrients.

Bran, Middlings and Hominy Meal.—These are not available in this country to any extent. The bran is considerably lower in food value than corn meal, but the middlings and hominy are somewhat higher.

Oats

Oats are very largely used in poultry feeding and are grown extensively in almost all parts of Canada. They are not so palatable as wheat and corn due chiefly to the hard fibrous hull. In light weight oats, where the proportion of hull is greater, this factor becomes a more serious objection. In most respects the nutrient properties of oats are similar to those of wheat and corn. Their content of vitamin A, however, is lower than either of these grains. During recent years machine hulled oats, known as oat groats, have been readily obtainable and at reasonable prices and have taken the place of whole oats to a very great extent in poultry feeding. Lacking the hull they are lower in fibre and more palatable. Hulled wild oats are also available in large quantities and appear to be as acceptable as the domestic groat. They are almost identical in analysis to the latter and are even slightly superior in some respects.

Oatmeal.—Oatmeal was formerly used to a considerable extent in the feeding of chicks, and at the present time pinhead oatmeal is used in nearly all chick-grain mixtures, but rolled oats are now used much more freely. It is a very valuable feed and where it can be obtained at a reasonable price, should be used. Many high-class breeders use it freely for the feeding of chickens even when they have to purchase the superior product intended for human food, and claim that even at that cost, the results justify its use. Ground oat groats are also usurping the place formerly held by other oat products in the mash ration to a great extent.

By-products of Oats.—By-products from the oatmeal mill are not now readily obtainable, as they are generally put into mixtures and sold as such. Oatmeal siftings or mealine is the best of these. It is an excellent feed and where obtainable may well be used.

Barley

There is very little difference in the analysis of barley and wheat, the barley being a little higher in protein. The hull makes it less palatable, but fowl soon become accustomed to it, and consume it readily. It might well be used to a far greater extent than it is, as it apparently gives almost as good results as wheat, and is usually much cheaper. Barley meal is used to a considerable extent, especially in crate feeding. It gives satisfactory results both in quantity and quality of flesh produced. It has recently been shown that barley may satisfactorily substitute for corn in poultry rations providing that a ration not otherwise deficient in vitamin A is fed.*

Brewers' Grains.—Brewers' grains, when fed fresh from the breweries, make an excellent feed, but care should be taken to see that they are fresh, as they are otherwise liable to flavour the eggs. Dried, they may be used to advantage as they keep well and are rich in both protein and fat.

Malt Sprouts.—In the process of malting to change the starch of the grain into sugar it is necessary to produce a natural ferment called diastase. To develop this ferment it is necessary to sprout the grain, and as it is the change that is desired and not the actual sprout, the sprouting is checked as soon as the change takes place. The whole is then kiln-dried and the sprouts are separated from the grain by means of sieves, and sold as stock feed. As they contain a high percentage of protein they make a valuable addition to a ration, but they are best fed in combination with more palatable feed, as they are not greatly relished.

Buckwheat

In some sections buckwheat is utilized to a considerable extent. Like oats, fowl have to become more or less accustomed to it, but once used to it they eat it readily. Ground buckwheat is especially valuable in crate feeding. It produces white flesh of fine flavour.

By-products of Buckwheat.—It is so seldom that the by-products of buckwheat can be had that they are hardly worth mentioning. The middlings are a high-class feed and may be used to advantage for feeding in mashes to any class of fowl.

Rye

Although, in analysis, rye shows very little below wheat in feeding value, it is in very little favour as a poultry feed. Fowl do not like it and, unless they are forced to eat it by having other grains curtailed, they will consume it in only very limited quantities. Its by-products are practically not available in this country.

Rice

Rice is rarely used except in the feeding of young chicks. There is generally broken rice in all chick grain mixtures, and in special instances it is sometimes boiled and fed like a mash, in which condition it is eaten with relish. Boiled rice is of especial value as a regulative in case of bowel trouble.†

Rice polishings, which are the polishings from brown rice in the process of refining to white rice for human consumption, are an excellent source of vitamins B_1 and E, and when available make an excellent supplement to the ration.

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* Canadian Grown Grains in Poultry Feeding—pamphlet No. 182 New Series, Dept. of Agriculture, Ottawa.

† See Experimental Farms Report for 1915, vol. II, page 1148.

Millet

Millet is very similar to oats in composition, but, like rice, it is used mainly in chick feeds. It appears to be particularly attractive to the chicks, as it is one of the first grains they will pick out when they are fed mixed grains.

Sunflower Seeds

Sunflower seeds are not fed extensively, but many town poultry keepers grow a patch of sunflowers for their fowls, bending the head down as soon as the seeds fill, and allowing the hens to help themselves. They are of especial value to " fanciers," who use them at moulting time and also for getting coloured birds ready for the show, as they give the coveted gloss to the plumage.

Peas

Peas are not used to any great extent, probably because they are not readily procurable at prices that would make them profitable to feed. They are a valuable and excellent feed and used in combination with other grains, are readily eaten and give very good results. Most chick feeds contain broken peas.

Linseed Meal

Flaxseed in the whole state is practically never fed, but ground flax, or linseed meal as it is called, is used to a considerable extent in mashes. It is very concentrated, and should be fed sparingly; otherwise, digestive troubles are likely to result.

Oil Meal.—Oil cake or oil meal is simply linseed meal from which the oil has been extracted by pressure (old process), or by dissolving out with naptha (new process). The former method gives a product higher in fat while the latter gives one slightly higher in protein.

Cotton-Seed Meal

Cotton-seed meal is another feed which requires caution in feeding, as it is not only a very rich feed, but it seems specially liable to cause digestive disorders. It contains a large percentage of protein but, for the reasons stated, it has not been used to a great extent in this country, and other feeds are preferred as a source of protein. It has also been shown to affect the keeping qualities of eggs deleteriously.

Soy Bean Products

Ground whole soy beans are rarely fed, but the oil cake meal from which much of the oil has been removed is used extensively. Soy beans are a fair source of a large variety of vitamins and are a valuable feed high in proteins which are adequate to support growth. The use of the oil cake meal is rapidly increasing in poultry work and the product has much promise for that purpose. The oil cake meal is the highest in protein of the commonly used vegetable feeds, usually analysing over 40 per cent.

Other Seeds

Other seeds such as sorghum, kaffir corn, rape and broom corn are all good feeds, but scarcely require mentioning, as they are used only in small quantities in chick-feed or scratch-grain mixtures.

GREEN FEEDS

It has been pointed out that grains alone are unable for various reasons to support normal growth and this applies regardless of the variety and combination of seeds used. This has been shown to be due mainly to two causes, viz., the fact that cereals are relatively deficient in minerals and vitamins. Green feeds, by which is meant chiefly the green leafy parts of plants, supplement the deficiencies of cereals in that they are high in vitamins and mineral content. Hence, growth, which is not supported on cereals alone can be greatly increased by the addition of green feeds to the ration. Thin leaved plants are relatively greater in food value than thick leaved ones, particularly in so far as their ability to supplement grains is concerned.

In the light of the above facts, it will be seen that green feeds in some form are a very valuable addition to the ration and particularly so in the case of poultry where grains and their by-products ordinarily make up from eighty to ninety per cent of the ration.

Form of Green Feed Supplements

Without doubt one of the most important considerations in choosing green feeds for poultry is the form in which they should be given. Owing to the relatively small capacity of poultry it is necessary to give them a very concentrated ration in order that they can consume sufficient feed to produce the enormous amount of food products per unit of body weight of which they are capable. Most fresh green feeds contain from 75 per cent to 90 per cent water, leaving therefore only a small percentage of their bulk to contain actual food nutrients of which a fairly large percentage is pure fibre and practically indigestible to poultry. Consequently if poultry are given large quantities of fresh green feeds, since they are very palatable, there may be a tendency to consume so much that the amount of the more concentrated foods which they are able to take in is seriously cut down and thus their total ingestion of nutrients is seriously diminished and production consequently suffers. This fact can be better appreciated if it is realized that the average consumption of a mature laying fowl is in the neighbourhood of four ounces of feed per day.

Green feed is available in two forms, namely, as dried leaves or plants and fresh, as cut green. Since as far as is known at the present time drying under proper conditions removes only water from the plant, dry leaves or plants contain proportionately more of minerals and vitamins than the fresh plant. Reference to the tables on vitamin (table 1) and nutrient (table 2) content of feeds will readily establish this point. The water lost in drying is available, fresh and cold from the drinking fountains in the quantity required.

While the data with regard to the comparative values of the same green feeds, properly dried as against the fresh form, are not sufficient to definitely establish their respective merits results obtained here would suggest that green feed in a properly dried form may be the equal of the same when fresh. Over three years, production and health were superior for birds receiving dried green feed (alfalfa leaf meal) as against others receiving steeped alfalfa, cabbage and mangels. This was not a controlled test, however, since it was not intended as an experiment to demonstrate the comparison under consideration and must therefore be accepted with reservations. In addition one pen of exceptionally good birds is now in its third year of apparently normal production and health having received only alfalfa leaf meal as green feed, in the mash, throughout. Also over a six months test (winter period) for two years, production and health was superior for a pen without green feed of any kind to a pen receiving cabbage, sprouted oats and mangels. Greater growth was also obtained with chicks in batteries when no green feed was given.

Alfalfa and Clover.—In vitamin and mineral content these legume plants show themselves to be the most satisfactory green feeds. Fresh or dry, they are palatable and nutritious and if well cured, the leaves of alfalfa or clover are a satisfactory form. Alfalfa meal or better alfalfa leaf meal from well cured alfalfa is a very satisfactory form of green feed mixed in the mash.

Garden Truck.—Cabbage, lettuce, onion tops, or practically any waste garden truck may be utilized in the poultry yard.

Rape.—Rape is one of the best crops to grow for geen feed for summer use where fowls are more or less confined. It is easily grown, gives a large yield, and fowls eat it with avidity. It is an excellent crop to freshen the runs after the breeding season.

Green Crops.—Corn, oats, rye, barley, and wheat all make good green fodder if cut at the right time and chopped into short lengths so that the fowl can readily eat them. They are especially useful in the feeding of waterfowl.

Jerusalem Artichokes.—Jerusalem artichokes are of much greater value as a crop for poultry feeding than is generally realized. The tops may be used as green fodder in summer or the tubers as roots for winter feeding. Both are readily eaten. The plant resembles the sunflower, but it is finer in growth, having smaller leaves, stalks, and flowers. Growing as it does to a good height, it also makes an excellent shade during the hot weather.

Succulent Feeds

Succulent feeds should not be classed with green feeds as they are much lower in feeding value. They are usually about 90 per cent water and lower in ash, protein and vitamins. Their chief function is of a regulatory nature and they tend to keep the digestive tract in healthy condition.

Beets.—For winter feeding mangels and beets are a handy form in which succulence can be provided. They are easily grown, yield a large amount of feed per 'acre, keep well, are handy to feed, and fowl are exceedingly fond of them. Care should be taken in planting them to see that the most suitable varieties are used. Some of the varieties of beets are not so readily eaten as others. Avoid planting those that are very hard in the flesh, as fowl prefer those that are tender.

Turnips.—Turnips are not so readily eaten in the raw state as are mangels, but when fowls become accustomed to them they eat them readily.

Apples.—Apples, especially some of the sweeter varieties, are eaten with relish by poultry, and where chickens are given the run of an apple orchard they will eat large quantities of windfalls.

Sprouted Grains

The use of sprouted grains, especially oats, is common, particularly among breeders. The process of sprouting is fairly simple, but necessitates additional equipment and a great deal of work. Whether the time and labour involved are justified is something which may be doubted, particularly if alfalfa or clover leaves, fresh or dry, or good quality alfalfa leaf meal are available. Certainly the practice of sprouting for green feed, that is, to two or three inches in length is of questionable value under these conditions.

If the production of germinated grain is under consideration, that is with sprouts about one half inch in length, a different object is in view namely the production of a digestive ferment known as diastase presumed to be of value in the digestive process, although to what extent this is so does not appear to have been established.

Methods of producing sprouted oats for green feed and also of germinated oats are given herewith.

Sprouting for Green Feed.—Soak the oats for twelve hours in warm water, then drain and allow them to stand for another twelve hours, after which they should be spread out about an inch deep where the drainage will be good. Water freely twice a day until ready for use, which in a suitable place will be in about six or seven days. It may be grown on the floor or in racks. When the grain is ready to feed it is taken out of the trays in a solid mat and torn or cut into pieces to suit the size of the flock. The little chicks will tear at this just as they would at a clover sod, eating the roots as eagerly as the tops.

Germinating Oats.—The method where the grain is simply germinated is followed where large quantities are required for the feeding of mature stock. The operation is simple and large quantities may be sprouted with comparatively little labour and in a building too cool to successfully grow the long-sprouted grain.

In this method the grain may be sprouted either in boxes or similar vessels, or on benches, but in either case, good drainage must be supplied. Take the grain that it is desired to sprout; put it into a bag; put sufficient water into a barrel so that the bag of grain may be immersed; allow the grain to soak for twenty-four hours; then hang up the bag for twenty-four hours to drain and heat, empty the grain into a pile and water, if the room is very cold the grain may be covered loosely with a bag to allow it to heat. The grain should be turned, loosened up, and thoroughly washed at least once a day.

When a sloping bench is used, the grain is started at one end and the sprouted grain removed from the other. Each day as the grain is turned and shaken up it is moved along the bench. A moveable board is used to separate the different lots, and as the grain becomes more bulky, more space is allowed. In this way a continuous supply is being worked over the bench. The method is simple, requires no expensive installation, and the minimum amount of labour.

ANIMAL FEEDS

Under the heading of green feeds it was stated that leafy materials supplement the deficiencies of grains, particularly in vitamins and minerals. A combination of grains and leafy materials, while supporting growth does not supply sufficient nutrients to bring about normal or optimum growth. It is necessary to supply a greater concentration of protein, particularly during the early stages of growth, as well as additional minerals. Products of animal origin, mostly in the nature of slaughter-house by-products are usually used as being the most concentrated source of protein available. The animo acids of the proteins of most meats are complete and satisfactory for growth, thus supplementing the proteins of grains and green feeds efficiently in this respect. Meat products are also an excellent source of minerals. They also contain some vitamins, particularly the liver and some other internal organs, but they are not considered to be as efficient and reliable a source of these vitamins as some others, and consequently are not commonly fed for that purpose.

Fresh Meats.—Fresh meat is perhaps the most relished form of animal feed, but there is often difficulty in securing it at a sufficiently low price to warrant its use. Horse flesh is available in some sections and makes excellent feed. Packing-house products, such as livers (see table 1) make the finest of feed and are valuable not only for feeding for heavy egg production but for feeding the breeding stock.

Green Cut Bone.—This is usually prepared by cutting up fresh bones from the butcher shop or slaughter house. Poultry eat it ravenously but should not be given too large quantities. It is only moderately high in protein but is high in minerals, consequently it may be considered chiefly as a mineral addition to the ration and as such should be given sparingly. As cut bone heats very rapidly, it is impossible to use it except in very cold weather, or where a fresh supply for each feed is obtainable.

Slaughter House By-Products.—Of these meat meals or meat scraps are by far the most commonly used and are the standard animal protein supplements to poultry rations. They vary greatly in analysis according to the amount of bone material they contain but are usually purchased on a guaranteed analysis. The poorer grades containing quantities of hoof and horn should not be tolerated as poultry feed as these products (hoof and horn) are practically indigestible to poultry.* With a little experience, it is possible to tell at a glance whether the brand is suitable for feed or not, but if in doubt, pour a little boiling water on a sample, and the smell arising should settle the matter even with the inexperienced. If the odour is foetid the sample is unfit for food.

Blood Meal and Tankage.—These, while satisfactory in analysis and used to some extent, are not the equal of good quality meat meals, consequently their use in poultry feeding is not recommended.

Fish Meal.—Fish meals of good quality make an excellent source of animal feeds for poultry. Of recent years, the processing of these products has been greatly improved with the result that fish meals are replacing meat meals to a considerable extent in poultry feeding. They are usually more completely digestible than meat meals particularly when low in fat. They are also much superior to meat meals in vitamin content and particularly is this the case when an appreciable amount of liver is present in the meal. While fresh fish in large quantities will affect the flavour of eggs, fish meals, unless very high in fat, under which circumstances they should not be fed, will not affect the flavour if fed at ordinary levels of feeding of animal feeds.

Milk and Milk Products.—Milk is well known to be the most complete of our animal foods. The fact that it contains normally 87 per cent of water makes it unsatisfactory as the sole source of protein even for larger animals than poultry, since the 13 per cent of dry matter available, mostly protein, sugars and fats, cannot be ingested in large enough quantities owing to the large amount of water which must be consumed to obtain sufficient nutrients. Consequently it is more valuable as a supplementary food and particularly so for poultry.

Dried skim-milk or buttermilk are the forms in which milk is often fed and these make an excellent protein supplement. They are well supplied with the minerals needed in greatest quantity (calcium and phosphorus) and are a good source of proteins. Price is usually the determining factor as to what quantity of these products is feed.

Semi-solid buttermilk overcomes to some extent the bulkiness which is the chief drawback of skim milk or buttermilk, and therefore makes a more efficient supplement than the latter.

In general it may be considered that milk in its various forms is an excellent food. Milk produces quality, whether in the growing stock, the laying pen, or the fattening crate, and, where milk-fed chicks have once been marketed, consumers will always ask for them.

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* Unpublished Data—Division of Chemistry, Experimental Farm, Ottawa.

Cottage Cheese.—Where an abundance of milk is available it may be used in the form of cottage cheese, which is greedily eaten by all kinds of poultry. This is prepared by allowing the milk to sour until it becomes thick. A gentle heat is then applied, which will cause the whey to separate from the curd. The whey is then drained off and the "cottage cheese" remains. This may either be fed as it is or mixed in wet mash.

Eggs.—Eggs are sometimes fed. These are usually infertile eggs that are tested out of incubators. Where good, sound eggs are used, they are a valuable source of food, but if eggs in which the germ has started and afterwards died are used, as they frequently are, it is necessary to use caution in feeding them, as they often produce bad results. Egg yolk is, with the exception only of cod liver oil, the best food source of vitamin D, the vitamin which is least widely found in natural foods, consequently its value to young chicks is considerable. In so far as is known, one disease only, namely, pullorum disease, is transmissible to chicks through the egg, consequently eggs from other than pullorum free stock should not be fed.

MINERAL FOODS

As a considerable percentage of the dry matter in both egg and fowl is composed of mineral elements, it is evident that with a rapidly growing bird or with a fowl that is producing a large number of eggs, the demand for food containing these elements will be urgent. Under free range conditions, these mineral elements will be largely obtained through the ordinary feeds, and the green food, grubs, and grit that are picked up on the range. When fowls are more or less closely confined, it becomes necessary to supply the mineral foods, and the question of the most suitable form in which they can be obtained becomes important. Besides what is supplied through the feeding of alfalfa, clover, bran, and other ordinary feeds, it is necessary to feed something that contains these elements in such quantities and condition that they can be assimilated more freely. Bones, shells, and grit are the feeds that are generally used to supply these requirements.

It has been demonstrated of recent years that the formation of bone is dependent not only upon the availability of sufficient quantities of the minerals calcium and phosphorus but also upon the proportion in which these minerals occur in the feeds. While research workers are not yet in agreement upon the matter, it appears that the consensus of opinion is that two parts of calcium to one of phosphorus is approximately the correct ratio, a ratio in which these minerals normally occur in bone. As previously pointed out the presence of vitamin D or sunlight is also necessary for proper assimilation of these minerals.

Mineral Mixtures.—It has been the practice in some quarters to recommend the use of mineral mixtures supplementary to the poultry ration. As a general rule such mixtures are of an empirical formula and based on judgment rather than actual ascertained fact. The feeds for poultry which have been considered in this bulletin under the various headings when intelligently used with sufficient variety can be counted on to supply sufficient of all minerals with the possible exception of calcium, phosphorus and common salt, special provision for the feeding of which has been made in these paragraphs. Since mineral requirements of poultry are not accurately known forced feeding by the means of incorporating a mineral mixture in the mash is not to be recommended, free choice as is commonly practised being the most logical method of attacking the problem.

Bone Meal.—As previously pointed out, bones contain calcium and phosphorus in approximately the proper proportions for utilization in the animal body. Bone meals are also a fair source of protein and are usually considered as a protein feed but are actually fed as a mineral addition to the ration and therefore in small quantities.

SHELLS AND LIMESTONE GRITS.—These are invariably given as free choice and should not be given ground in the mash. The requirement for calcium of poultry varies greatly according to growth, rate of egg production, etc., and they must have free choice of calcium to balance their consumption with requirements. Crushed oyster shells are the most satisfactory source and contain usually in the neighbourhood of 98 per cent pure calcium carbonate. Limestone grits, if comparable in calcium content, are apparently also satisfactory, although this has not been very definitely established at time of writing. If high in magnesium it has been shown that they are undesirable as a calcium supplement.

SALT.—Common salt is essential to the well being of all animals. Since it is poisonous if fed to poultry in quantity, their requirement is probably quite low. It is usually included in poultry mashes at levels of from one-half to one per cent.

TABLE 4—MINERAL SALTS IN FEEDING STUFFS

AVERAGE CONTENT IN 1,000 PARTS OF FRESH OR AIR-DRIED SUBSTANCE

Feeding stuffs	Water	Ash	Potash	Sodium	Lime	Magnesia	Phosphoric acid	Sulphuric acid	Silicic acid	Chlorine
GREEN FORAGE										
Meadow crops in bloom	750	20·3	5·8	0·6	2·7	1·2	1·2	0·9	7·9	1·0
Rich pasture	780	21·5	8·7	0·3	2·5	1·1	1·9	0·7	3·4	1·7
Grass, young and second crop	800	18·0	5·3	0·7	1·6	1·2	1·4	0·9	4·6	1·0
Feed rye	760	16·3	6·3	0·1	1·2	0·5	2·4	0·2	5·2	0·6
Oats, green	810	14·2	5·6	0·5	0·9	0·4	1·3	0·5	4·4	0·6
Grains in bloom	785	15·0	4·4	0·3	0·9	0·4	1·4	0·4	6·2	0·6
Alfalfa, beginning bloom	740	17·0	3·0	0·3	7·8	0·9	2·0	1·1	1·8	0·7
Red Clover, very young	860	13·8	4·9	0·3	3·9	1·2	1·6	0·3	0·4	0·5
Red clover, in bud	820	13·1	4·8	0·2	3·9	1·4	1·3	0·3	0·3	0·4
Red clover, in bloom	800	13·7	4·4	0·2	4·7	1·5	1·3	0·4	0·3	0·4
White clover, bloom	800	14·2	3·0	0·8	3·5	1·1	1·8	0·8	0·6	0·6
Peas, green	815	13·9	5·2	0·5	3·5	1·4	1·5	1·1	0·2	0·4
Rape, beginning of bloom	870	10·5	3·5	0·4	2·3	0·4	1·2	1·5	0·5	0·8
Buckwheat in bloom	850	12·4	3·8	0·3	5·0	1·6	0·8	0·5	0·1	0·1
LEAVES AND TOPS OF ROOT CROPS										
Field beets	905	13·0	2·5	3·5	1·6	1·4	0·8	0·8	0·5	2·5
Sugar beets	800	16·0	3·5	3·0	1·5	1·1	1·0	0·5	0·8	1·0
Turnips	890	12·0	2·9	1·1	3·9	0·5	0·9	1·1	0·5	1·2
Kohlrabi	880	19·6	2·8	0·8	6·5	0·8	2·0	2·3	2·1	1·5
Carrots	820	20·5	2·5	2·0	7·9	0·8	1·0	1·8	2·4	1·5
Artichokes	800	14·5	3·1	0·2	5·0	1·3	0·7	0·2	3·6	0·4
Potatoes, nearly mature	770	20·5	4·5	0·9	6·4	3·3	1·6	1·3	0·9	1·5
HAY										
Meadow hay	140	70·0	20·0	2·2	9·5	4·0	4·3	3·0	27·2	4·0
Second growth	150	76·0	22·3	3·0	7·0	5·0	5·9	4·0	19·4	4·5
Rich pasture	150	84·0	34·0	1·3	10·0	4·6	7·5	2·6	16·0	8·0
Cereals, in bloom	150	59·4	19·3	1·0	3·4	1·7	5·6	1·5	24·7	2·3
Alfalfa, beginning bloom	160	63·0	15·0	1·1	25·2	3·1	6·5	3·6	5·0	2·5
Red clover, very young	160	78·0	25·5	1·9	23·5	7·6	10·0	1·8	2·5	3·3
Red clover, in bud	160	63·0	20·5	1·4	20·7	7·6	6·9	1·7	1·8	2·4
Red clover, in bloom	160	54·0	15·0	1·1	20·1	6·3	5·6	1·9	1·6	2·2
Red clover, mature	150	46·5	12·0	1·4	15·8	6·9	4·4	1·4	3·0	1·3
Sand vetch, beginning bloom	160	69·0	20·0	0·8	18·1	5·7	9·7	4·3	7·3	2·5
White clover, in bloom	160	61·0	13·0	4·4	18·4	5·8	7·8	4·5	2·7	2·6
Vetches, green, in bloom	160	45·5	10·0	2·4	16·3	4·6	6·2	3·4	1·1	1·4
Peas, green	160	59·5	20·0	2·3	15·6	6·3	6·8	5·1	0·8	2·0
Rape, beginning bloom	160	68·0	22·6	2·3	15·0	2·7	7·6	9·5	3·2	5·0
Buckwheat, in bloom	160	69·1	21·4	1·6	27·9	9·2	4·2	2·5	0·8	0·5
ROOT CROPS										
Field beets	900	6·5	2·8	1·5	0·3	0·4	0·6	0·3	0·2	1·0
Sugar beets (new varieties rich in sugar)	750	5·3	2·3	0·7	0·6	0·5	0·8	0·2	0·2	0·2
Turnips	920	6·4	2·9	0·6	0·7	0·2	0·8	0·7	0·1	0·3
Carrots	850	8·2	3·0	1·5	0·9	0·4	1·1	0·5	0·2	0·4
Artichokes	800	10·8	6·2	1·0	0·3	0·3	0·6	0·6	0·2	0·4
Potatoes	750	9·5	6·0	0·2	0·3	0·5	1·2	0·6	0·2	0·4

TABLE 4—MINERAL SALTS IN FEEDING STUFFS—*Concluded*

AVERAGE CONTENT IN 1,000 PARTS OF FRESH OR AIR-DRIED SUBSTANCE

Feeding stuffs	Water	Ash	Potash	Sodium	Lime	Magnesia	Phosphoric acid	Sulphuric acid	Silicic acid	Chlorine
GRAINS AND SEEDS										
Winter rye	140	18·9	6·0	0·6	0·5	2·0	8·5	0·2	0·3	0·6
Summer rye	140	19·0	6·0	0·6	0·5	2·0	9·2	0·2	0·2	0·6
Summer wheat	140	19·9	6·0	0·5	0·5	2·2	8·5	0·2	0·3	0·5
Summer barley	140	25·5	7·0	1·0	0·6	2·0	8·0	0·4	6·0	1·5
Oats	140	26·5	5·0	0·5	1·0	1·3	7·0	0·5	10·5	0·5
Corn	140	12·8	3·7	0·1	0·3	1·9	5·7	0·1	0·3	0·2
Sorghum	140	16·0	3·3	0·5	0·2	3·4	8·1	.....	1·2	....
Millet	140	29·5	3·3	0·4	0·2	2·8	6·5	0·1	15·6	0·1
Peas	140	27·5	12·5	0·2	1·1	1·9	10·0	0·8	0·2	0·4
Soy beans	100	28·3	12·6	0·3	1·7	2·5	10·4	0·8	...	0·1
Feed vetch	140	26·6	8·0	2·1	2·2	2·4	9·9	1·0	0·3	0·7
Rape	120	39·2	9·6	0·6	5·5	4·6	16·6	0·9	0·5	0·1
Hemp	120	46·3	9·4	0·4	10·9	2·6	16·9	0·1	5·5	......
Buckwheat	140	11·8	2·7	0·7	0·5	1·5	5·7	0·2	.....	0·2
FRUIT										
Apples, whole fruit	830	2·2	0·8	0·6	0·1	0·2	0·3	0·1	0·1	....
COMMERCIAL PRODUCTS AND BY-PRODUCTS										
Wheat bran	130	53·5	15·3	0·3	1·5	9·0	26·9	....	0·2	......
Wheat, bread flour	120	11·2	3·5	0·1	0·6	1·4	5·6	....	......	....
Wheat, fine flour	130	4·4	1·5	....	0·3	0·4	2·2	......	....	......
Barley meal	140	20·0	5·8	0·5	0·6	2·7	9·5	0·6	....	.....
Corn meal	140	5·9	1·7	0·2	0·4	0·9	2·7	...	..	....
Rice feed meal	100	54·7	6·1	1·2	1·2	9·5	23·8	0·2	10·3	.....
Malt sprouts	120	67·7	20·8	1·2	1·9	1·9	18·2	2·7	14·9	4·7
Cottonseed cake	110	66·4	15·8	....	2·9	10·1	30·5	0·8	5·5	....
Linseed cake	120	51·3	12·5	0·8	4·3	8·1	16·2	1·7	6·4	0·4
Rapeseed cake	110	57·0	13·0	1·9	7·1	7·3	20·0	3·4	2·9	0·4
ANIMAL PRODUCTS										
Colostrum	730	11·8	0·9	0·7	4·1	0·2	3·3	...	...	1·3
Cow's milk	875	7·2	1·7	0·4	1·7	0·2	2·0	0·1	..	1·0
Skim milk	910	7·9	2·1	0·5	1·7	0·2	2·2	0·3	..	0·9
Whey (cow's milk)	930	5·4	1·7	0·7	1·0	.	0·9	0·2	..	0·8
Tankage	115	15·9	0·9	0·5	3·6	0·6	6·9	0·2	0·1	0·3
May bugs (fresh)	704	13·4	5·0	0·8	0·4	1·1	5·6	0·2	0·2	.
Ox blood	790	7·9	0·6	3·6	0·1	......	0·4	0·2	0·1	2·7
Oyster shell	....	.....	.....	....	527·8	..	..	.....	..	...
Clam shell	5·8	....	....	.....	531·1	14·1	Traces	....	....	.....

NOTE.—All data in this table taken from Scientific Feeding of Domestic Animals by Klimmer, translated by Paul Fischer, except for oyster shell and clam shell which is from an analysis by the Dominion Chemist.

MISCELLANEOUS FEEDS

COD LIVER OIL.—The use of cod liver oil in poultry feeding is accepted practice at the present time. The requirement of poultry for vitamins A and D has been demonstrated to be exceptionally high and cod liver oil of good quality is the best practical source of these vitamins. For birds in confinement, away from sunlight, it is essential at all times and should be used for all birds from October to March inclusive since the sun's rays are not very potent in ultra violet rays (the equivalent of vitamin D) at that time. Cod liver oil has been shown to prevent rickets and improve growth as well as improving egg production, quality of egg shells and hatchability.

PILCHARD OIL.*—This oil, produced on the coast of British Columbia, has been shown by work at this Farm to be equal to poultry cod liver oil in supplying both vitamins A and D to the ration and can therefore be used like cod liver oil when available.

In considering these oils it is preferable to buy an oil biologically tested for poultry use if available. This means that the oil has been tested upon rats or chicks by the manufacturer and found to be potent in these vitamins. In addition some cod liver oils are produced which, although they may be potent in vitamins, are so rancid and unappetizing as to be unsuitable for feeding purposes. These oils are usually produced by the " sun rotting " process.

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* See reference at foot of Table 1.

GRIT.—Under range conditions, poultry will pick up large quantities of broken stone of one kind and another. It has been fairly definitely shown however, that the requirement for grinding purposes is very small since grit has been shown to remain in the gizzard for as long as two years when one feed only was given, normal grinding and assimilation of food, proceeding. Consumption of large quantities is therefore probably due more to a seeking for mineral content rather than for material for grinding.

CHARCOAL.—Charcoal is not a feed in any sense of the word but is used for its high adsorptive qualities. It adsorbs gases and injurious by-products of digestion from the digestive tract and keeps it in a sweet condition. It should be available ad lib in hoppers.

EPSOM SALTS.—Epsom salts are useful as a laxative or purgative depending upon the amount given. They should be given only when needed as evidenced by unthriftiness and impaired digestion and in medium doses only. For mature stock not more than 12 ounces per one hundred birds in a wet mash and for growing stock from 3 ounces to 8 ounces per 100 chicks from three to eighteen weeks of age, proportionate increase in amounts.

CONDIMENTS.—Condimental foods are widely used for egg production. Under conditions of low vitality, usually brought about by some disease condition, a well made up tonic is probably of some use as a temporary stimulant over a bad period. It has been shown that some of the best condiments are of no value fed over a period to increase egg production and constitute a type of product not to be recommended for poultry feeding.

FEEDING METHODS

There are many feeding methods which give fairly satisfactory results. A certain amount of pliability is essential in this regard since the method may normally vary according to the result desired. In any event, regularity in feeding and method is highly desirable since poultry are fairly sensitive to change in habits and environment.

The Hopper System

The feeding of a dry mash in hoppers is very popular, especially on large plants where labour has to be considered. This system has some advantages and some disadvantages, but the former greatly overbalance the latter.

The principal disadvantage has been in the past the wasting of feed by scattering it out of the hoppers. This can be entirely avoided, however, by the use of properly constructed hoppers.

As recently as 1926 it was generally recommended that chicks should be fed only intermittently for fear of over-feeding and resultant digestive trouble. Work at this Farm[1] showed definitely that this was a fallacy and that dry mash could be left before the birds continuously with lower mortality and greater growth resulting. Hence the hoppers are left always before the birds. Research here[2], at the same time, demonstrated that chicks could be fed immediately upon coming from the incubator (approximately 24 hours old) with less mortality and greater growth than the system of waiting for from forty-eight to sixty

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[1] See Annual Report of the Dom. Poultry Husbandman, 1927.
[2] See Annual Report of the Dom. Poultry Husbandman, 1929.

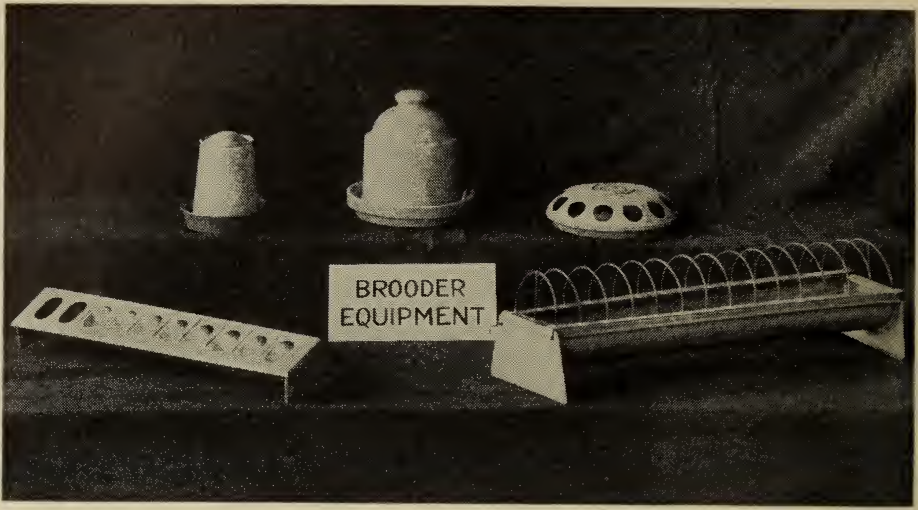

Fig. 2.—Water fountains and feeding hoppers for use with small chicks and during the early rearing stage.

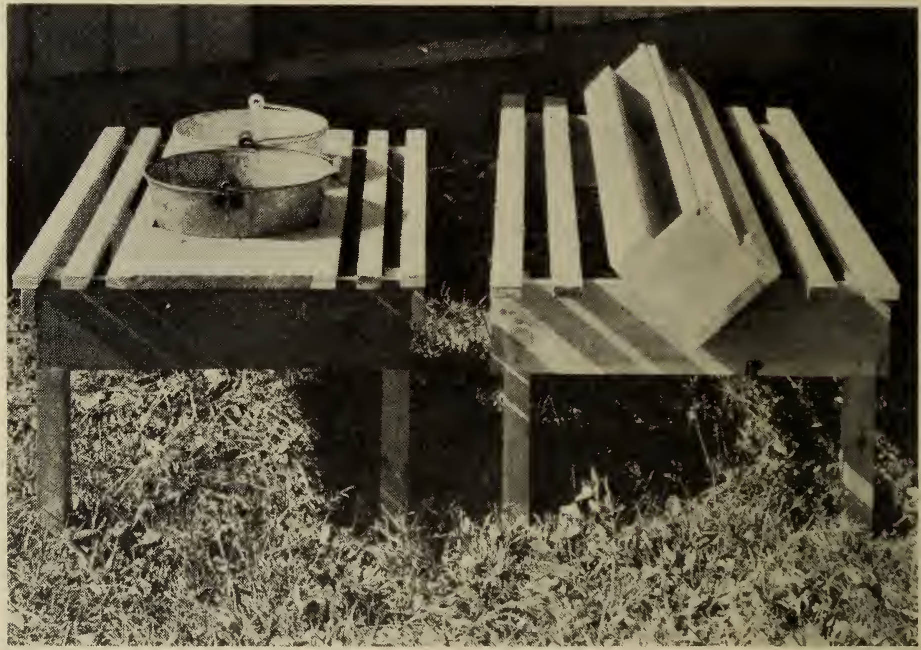

Fig. 3.—Mash hopper and water stand for laying house. The water stand can be conveniently made 22 by 36 inches and the mash hopper 24 by 60 inches over all. The former may be still further reduced where but one pail of water is sufficient. The actual hopper without stand is 12 by 60 inches.

hours of age, as was then the practice. Consequently most satisfactory results with the minimum of labour can be attained by hopper feeding dry mash continuously from time of hatch on.

Where scratch grain is fed, either to young stock or laying birds it is becoming increasingly more common practice to feed the scratch grain also in hoppers in order to avoid contaminating the grain by coming in contact with the bird's droppings as it would do if broadcasted on range or upon the house floor. Under these conditions greater hopper space is required.

The all mash system of feeding birds has many advocates, and it seems apparent from research work to date that both young and mature stock will remain normal in every way under conditions wherein they receive no scratch grain but a suitable mash mixture always before them in hoppers. This represents the most simple method of feeding yet introduced. Its chief disadvantages would be that it would not be possible to increase the proportion of carbohydrates to protein, i.e. widen the ration, when the condition of the birds warranted it, without mixing a new mash to a different formula, whereas with scratch grain the ration may be widened or narrowed at will very simply by increasing or decreasing the amount of scratch grain fed. In addition, a feed of scratch grain just before going to roost probably supplies nourishment for a longer period during the night owing to the less rapid digestion of hard grains. Under northern conditions of cold winter nights this factor may be of importance.

Moist Mash Feeding

The feeding of a daily moist mash was formerly the favourite method among poultry keepers, and even yet many stick to this method in preference to the hopper system.

Some prefer feeding it in the morning, some at noon, and some at night. The time is really immaterial, and should depend on the convenience of the feeder. When moist mashes are fed they should be given only in such quantity as will be cleaned up in one-half hour or less to avoid fermentation and digestive troubles.

A combination of moist and dry mash feeding is often used, hoppers of dry mash being before the birds at all times and a moist mash being given once a day, usually at noon. Extensive tests upon the Experimental Farm's system over a period of years indicated that nothing was gained by feeding moist mashes and the time and labour involved are considerable.

The chief advantage of feeding a moist mash is that table scraps and kitchen waste may be fed in this manner, and it is usually a small flock proposition. Moist mash is more palatable to the birds but total consumption of feed is not thereby increased.

RATIONS

The compounding of suitable rations for the different purposes required is a matter requiring an intimate knowledge of the feeding values of different feeds, the main features of which have been set forth in this bulletin. Rations giving fair satisfaction are easily made up with the feeds on hand and paying attention only to the most important principles of feeding. However, in order to get optimum growth or egg production the proper balance between various ingredients must be maintained and some judgment exercised in adjusting the ration to suit the environment.

Availability of the various ingredients will be one of the first considerations and where a limited number of ingredients only are obtainable it will be necessary to choose them so that no essential nutrient is lacking for growth or production as the case may be. Cost will also always be an important feature and where economies can be made without unduly sacrificing efficiency in the ration, this should, of course be done.

Rations for Young Chicks

As previously mentioned chicks should be fed immediately upon entering the brooder house from the incubator, which is usually at about twenty-four hours of age. Also they may have dry mash set before them at that time and continuously from then on. It is advisable to put down some chick size grit just before feeding and they should have access to fine oyster shell as well.

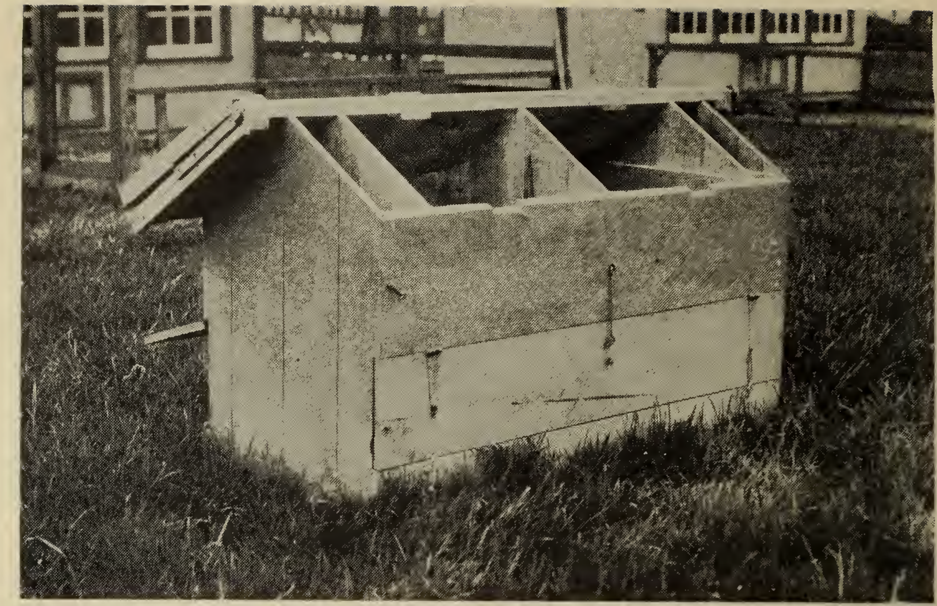

FIG. 4.—Field hopper—The cover is opened back to show compartments for different feeds. The feeding door is closed.

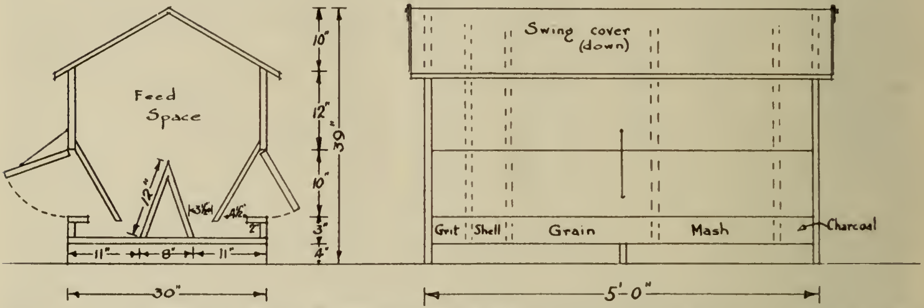

FIG. 5.—Field hopper—Front elevation and section of field hopper shown in Fig. 4. The top is covered with ready roofing. This stops short of the ridge over which is fastened, with cement paint, a strip of heavy canvas, thus making an absolutely watertight cover.

The composition of the mash during the brooding period (12 to 14 weeks) should be considered with care. It has been shown that during this period their requirement for protein is relatively high and they are tolerant of a very high level of protein at this time. For bone formation they also require a relatively high mineral level.

A mash used at this Farm has given excellent results and may be considered as fairly typical of brooding rations. The mixture is as follows: Wheat bran, 11 per cent; alfalfa leaf meal, 11 per cent; wheat middlings, 22 per cent; yellow corn meal, 22 per cent; ground oat groats, 22 per cent; meat meal, 6 per cent; fish meal, 2 per cent; buttermilk powder, 2 per cent; bone meal, 2 per cent; one-half pound of common salt and one pound of cod liver oil are added to each 98·5 pounds of the above mixture.

The above mash is fed alone until ten to twelve weeks of age, at which time a small amount of scratch is fed increasing the quantity gradually to widen the ration, as the chicks in development require a less concentrated mixture. The same ration is used until maturity since by increasing the scratch grain fed the necessity of mixing a rearing ration is done away with.

In considering the above ration, attention should be drawn to the fact that alfalfa leaf meal, which is made of dried, ground leaves and blossoms of alfalfa is used in preference to alfalfa meal which contains too much fibre for small chicks. Also, it has been shown that when cod liver oil is fed, as in this ration, ground barley may be substituted for the yellow corn meal. Since ground barley is much higher in fibre than corn meal the lower fibre ingredients such as middlings and ground oat groats should be increased slightly and the barley cut down a little so as to give a similar fibre content to the ration. If ground oat groats are not available well ground whole oats may be used providing they are plump. Since whole oats are quite high in fibre adjustment of the low fibre feeds would have to be made as before. If at all possible, however, it is recommended that the ground groats be used. In the event of inability to obtain one of the animal feed ingredients, a certain amount of leeway is possible in the interchange of meat meal and fish meal. Buttermilk powder, however, is usually high priced and therefore not economical to feed in larger proportions, while bone meal, since most meat and fish meals contain a fair proportion of bone and since it is fed chiefly as a mineral supplement, should not be fed at a higher level.

Since the above ration as actually set down has consistently proven capable of giving excellent results, it is preferable to mix it exactly according to formula. The digressions mentioned above should be considered only when absolutely necessary, as they are given as a guide to formation of rations and to show the reasoning behind the compounding of such a ration. The nutrient analysis of the above ration may be readily made up by the use of the analyses in table 2 or table 3. When changes are made they should be done in such a way that the actual analysis of nutrients of the mash is not interfered with.

Cod liver oil, as fed in the above mash is a vitamin supplement only and is given to supply vitamin D which is essential to proper bone formation and vitamin A which is essential for growth. When the chicks get outside on range in the sunlight their vitamin D requirements are satisfied by the ultra violet rays of the sun. Also if their range is good (green clover or alfalfa) they obtain large quantities of vitamin A from these greenfeeds. Under these conditions, cod liver oil may be left out of the mash or at least reduced by one half in quantity. Until such conditions are the case, however, it is essential to normal development in the chicks.

Grit, oyster shell and charcoal should be available in the hoppers at all times.

Laying Pullets

When pullets are put into laying quarters off range, where they have had an abundance and variety of green feed with unlimited fresh air, housing conditions should be made to resemble range conditions as much as possible, all changes being made gradually.

Lights judiciously used, increase production during the winter period but do not have an appreciable effect upon the egg production for the whole year. Pullets in a satisfactory plane of nutrition may be subjected to lights to give an eleven or twelve-hour day without their being forced in any way and without endangering their general well being and consequently their quality as breeders. Under conditions of malnutrition or improper care this would not necessarily hold.

A laying ration which has given excellent results at this Farm is made up as follows: Mash—½ part alfalfa leaf meal, ½ part bran, one part each of middlings, ground yellow corn and ground oat groats, animal feed mixture ½ part (meat meal, fish meal, milk powder), + 2 per cent bone meal, 2 per cent cod liver oil, and 1 per cent common salt. Grain fed according to body condition.

Also another laying ration which has given excellent results experimentally at this Farm is made up as follows: Scratch grain in the proportion of two parts of grain to one of mash. This end is gained by weighing the mash and grain periodically to determine the consumption of each and increasing or decreasing the grain to maintain a two to one proportion.

A mash of the following formula was used: Wheat bran, 13 per cent; alfalfa meal, 13 per cent; ground oat groats, 20 per cent; ground whole barley, 20 per cent; wheat middlings, 12 per cent; meat meal, 6 per cent; fish meal, 4 per cent; bone meal, 3 per cent; buttermilk powder, 3 per cent; cod liver oil, 6 per cent. In addition 1 pound of salt was added to each 99 pounds of this mixture.

In considering this mash it should be pointed out that since scratch grain makes up two-thirds of the ration and is relatively low in fibre, it was found necessary to use more fibrous feeds in the mash and hence the use of alfalfa meal instead of alfalfa leaf meal. Corn meal might be used in place of ground barley if necessary but the fibrous feeds would have to be increased which might be satisfactorily done by using ground whole (plump) oats in place of the groats. Cod liver oil at 6 per cent level represents only 2 per cent of the total ration with two-thirds of grain to one-third mash. It cannot be definitely said that cod liver oil at 1 per cent of the total ration (3 per cent of the mash) is not equally satisfactory as work on this subject is in its initial stages only. At any rate, from April to September inclusive, this may be reduced to 3 per cent of the mash or 1 per cent of the ration, or if the birds are on range during these months it may be eliminated for that period.

It has been observed that birds under heavy production have a tendency to lose body weight. Loss of body weight under these conditions is undoubtedly due to inability to consume sufficient feed to produce at a rapid rate and maintain body weight or to a ration unsuitable to the maintenance of body weight under these conditions. If rapid production continues a breakdown in the form of a moult or in lowered body condition is an inevitable result. With the cessation of production, the bird will again gain body weight and replace feathers eventually coming into production again. By feeding a ration suitable to maintain body weight, that is one high in carbohydrates such as is the case with large proportions of grain, unless the bird has other physical limitations, body weight may be maintained and prolonged production at a high rate made possible. Thus by keeping track of the body weight of the birds and increasing the amount of scratch grain when loss is shown, better condition and production may be obtained. A proportion of two parts of grain to one part of mash has so far proven most satisfactory at this farm although the proportion should be varied as closely as possible according to condition of body weight.

If an all mash ration is desired the scratch grain may be ground and added to the mash in the ratio of two to one.

Green feeds, preferably dried clover or alfalfa leaves, may be given but not in too large quantities for reasons explained under the heading of Green feeds. Charcoal, grit and shell should be before the birds in hoppers at all times.

Breeding Birds

The breeders should be fed a varied ration similar to that of the pullets except that it should not be quite so concentrated. Mineral and vitamin supplements are even more important for breeders than for pullets. Consequently fresh or dry green feeds, such as alfalfa or clover leaves and blossoms, should be fed at higher levels than for pullets. Cod liver oil of good quality at a level of 2 per cent of the ration is essential during the winter months. Alfalfa leaf meal may be increased considerably in the mash mixture. Fresh green range, where climate permits of it, is excellent under these conditions. Grit, oyster shell and charcoal should be always available.

Fattening and Finishing

In crate feeding, the use of milk is indispensable where high quality is an object. The milk is mixed with finely ground grain in about the proportion of three pounds of milk to two of grain. This makes a rather thin mash. The birds are fed all they will eat twice a day, at regular intervals, and any food that is left is removed immediately, so as to keep the appetite keen. It is customary to mix a mash a feed ahead so that fermentation may begin before it is fed.

The grains most commonly used are corn, oats, barley and buckwheat, or some of their by-products, but whatever is used should be finely ground. Corn produces a yellow fat, so that, where white skin is in demand, it is advisable to use it with caution. Mixtures that will be found to give satisfactory results are equal parts, ground corn, ground oats and ground buckwheat; equal parts of ground wheat, ground barley and ground oats; equal parts wheat middlings, ground oats and chopped raw potatoes.[1]

From experiments conducted at the Central Farm it was shown that " buckwheat screenings "[2] give excellent results. This is a by-product from the elevators, and is composed largely of the seeds of " Wild buckwheat " and shrunken wheat, although there is also a proportion of other seeds. This feed is usually cheap, and as it is palatable and gives such excellent results, it is highly recommended. It is fed mixed with sour milk in the usual manner.

TURKEYS*

Domestic turkeys partake largely of the habits of their wild ancestors, and if they are given as much opportunity as possible to gratify their wild instincts, such as ranging over unlimited areas in search of their food, and roosting in whatever sheltered tree or nook they may select, there will be a minimum mortality. Kept under such conditions it will be found that the poults will be very little more difficult to rear than chickens.

What has been said in the previous pages with reference to the principles of feeding apply equally to turkeys and other poultry as to ordinary fowl. The necessity for strict sanitation cannot be too greatly emphasized. The great advance that has been made in the successful rearing of turkeys during recent years is largely due to a realization by growers, of the necessity for feeding in such way as to avoid contamination of the feed.

All feed given should be supplied in dishes which are kept scrupulously clean. No feed should ever be fed on the ground. The feed dishes should be placed on wire covered stands so that any feed spilt will fall through the wire mesh and so prevent the poults from picking it up once it may have become soiled.

POULTS.—The poults are started in the same manner as chicks, that is, they are allowed to rest in the incubator (or under the mother) for a day after hatching to gain strength, after which they are moved to the brooding quarters. Dishes of water, sour milk, fine grit ond oyster shell and chick starter should be supplied on the feeding stands. As poults are inclined to look for their feed above their heads, picking insects or seeds off growing plants rather than off the ground, a little difficulty may be experienced in getting them to start feeding. In such cases if a little moistened feed is held in the hand where the poults have to reach for it, they will take it more readily than if they have to pick it out of the dishes. Many turkey growers prefer to hand feed at the start, using moist feed, usually either chopped hard boiled eggs mixed with bread crumbs or bread crumbs or mash mixed with sour milk or milk curds (cottage cheese) in which is mixed chopped greens such as, onion tops, dandelion or similar succulent feed. If this method is followed care should be taken to see that the poults are not over fed and that moist feed is not allowed to remain standing before them after they have fed; as stale feed is always a source of danger. The dishes should be carefully washed after each feeding.

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[1] Preparing Poultry Products for Market, Dept. of Agriculture—pamphlet No. 125 New Series, Ottawa.

[2] See Experimental Farm Report for 1914, pp. 969-973.

* See Experimental Farm Bulletin, No. 149, New Series.

Whatever method is adopted the poults should be liberally supplied with green feed.

As soon as the poults are strong enough they are allowed to range, but up to the time of "shooting the red" which is at about six weeks of age, care should be taken to see that they are not allowed out in wet weather as they are liable to become chilled.

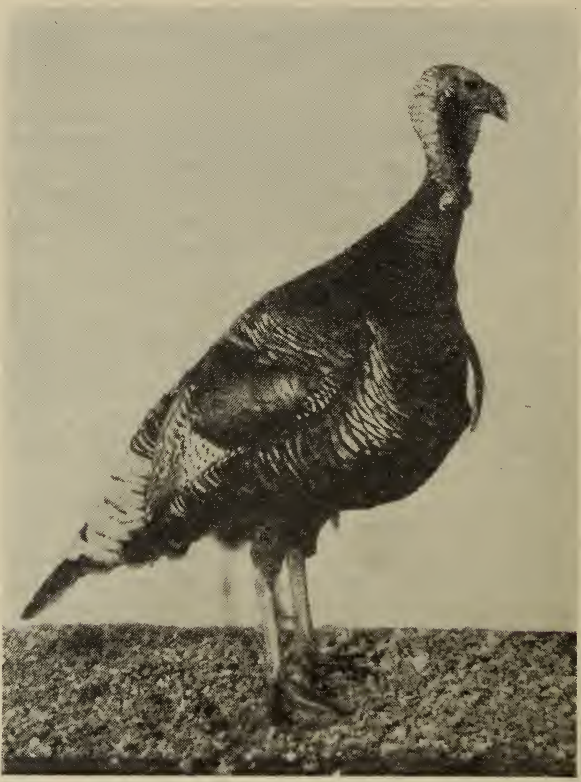

FIG. 6.—Bronze turkey cock. This bird is representative of the largest breed.

ON RANGE.—The wider the range the less necessity for supplementary feeding. A light feed of mash may be given in the morning, and grain at night, the quantity depending on the avidity with which it is eaten.

FATTENING.—Turkeys that have been on good range require very little fattening. For two to three weeks before killing they are fed all they will consume of ground grains mixed with sour milk, with an occasional feed of corn as a change, being brought on to full feed gradually.

STOCK BIRDS.—In feeding the breeders during the winter, the great danger is in getting them too fat. Dependence should be placed largely on alfalfa or clover hay and scratch grain. The scratch grain should be fed sparingly and always in a deep litter so that the birds will have to work for all they get. Grit, oyster shell and either water or snow should be always available. As the time that eggs are wanted approaches, the rations are gradually increased until they are similar to that recommended for ordinary fowl stock birds.

GUINEA AND PEA-FOWL

Guinea and pea-fowl, and birds of similar nature, are handled in the same manner as turkeys, and the ration suitable for the one is equally suitable for the others.

DUCKS

Ducks are voracious feeders, and it is necessary to supply roughage in the form of green feed, hay or roots, liberally. Otherwise, if they are fed generously, not only will the keeping cost be too high, but they will become too fat to reproduce properly.

If ducks are on grass range they will thrive on any ration that is suitable for ordinary fowls, but for profitable production it is advisable to feed largely on coarse, bulky feeds.

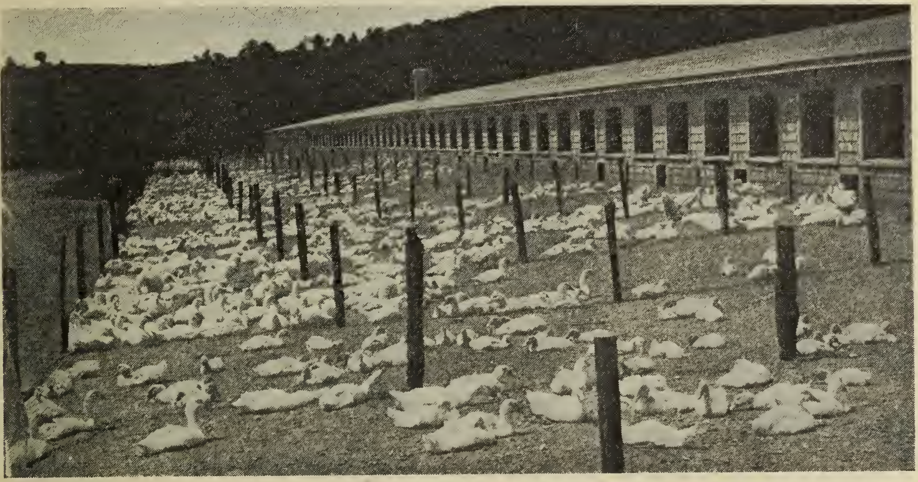

Fig. 7.—Scene at Brome Lake Duck Farm, Knowlton, Que. Where 20,000 to 30,000 ducks are raised annually.

Ducklings.—When the duckling are put into brooding quarters they are supplied with fresh water and for the first couple of days moistened mash is kept before them all the time; this is changed from time to time so as not to allow it to become stale. When the ducklings have learned to feed properly regular feeding times are established, the rule being about five feeds a day.

The mash used at the Farm is made up of equal parts bran, shorts and cornmeal, 10 per cent beef scrap and 3 per cent sand. Chopped green feed is added to this, the amount being gradually increased until there is as large a percentage of green food used as the ducklings will clean up; this will amount to 20 to 30 per cent in bulk by the time the ducklings are a couple of weeks old. If an inclination to pick out the grain part of mash and leave the green feed is noticed the proportion of green food is reduced.

This ration is continued for about six weeks when the flock is divided and those ducks to be reserved for stock purposes are given a large run where they have access to a stream and where they can forage for much of their feed, while those intended for market are put on a fattening ration.

Fattening.—For fattening the proportion of corn is increased and the green feed gradually eliminated. At the beginning of the seventh week the mash is made up, in the proportion of 50 pounds of cornmeal to 35 pounds of shorts and 15 pounds of meat meal; 3 per cent sand is added to this mixture.

By the time the ducklings are ten weeks old they should be in prime condition for market. If they are kept past this period they will go into a moult, with a consequent loss of weight and will not again be in fit condition to dress until the moult is completed. This will mean that any profit will be greatly reduced if not entirely eliminated.

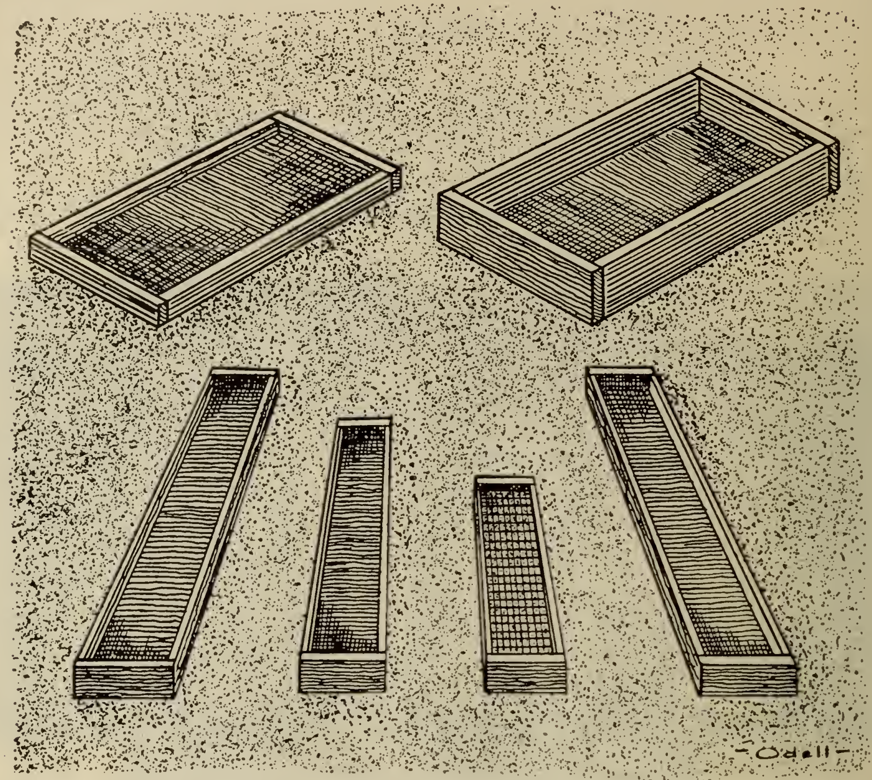

Fig. 8.—Simple troughs—This type of trough has been found very useful. Those on the top which are made out of 10 or 12 inch boards about 12 or 15 inches long are convenient for feeding mash to chicks or hens. For chicks a strip about 1½ inches high is nailed around the board, for hens a strip 3 or 4 inches wide is used. Those on the bottom row are similar except that they are made long. They are used for duck feeding. The third trough from the left illustrates how the same type of trough may be arranged for feeding chicks dry mash. A strip of ½ inch mesh wire is laid over the feed to prevent the chicks from scratching it out.

Stock Ducks.—After ducks intended for breeders are separated from the market stock at six or seven weeks of age, they are given a light feed in the morning and a full feed at night of the following mash: bran 3 parts, shorts 2 parts, corn chop 1 part, with 5 per cent beef scrap and 3 per cent sand, and as much green feed as they will eat. One of the feeds or at least a part of it, should consist of mixed grains, principally oats and barley. If the range is good, the morning feed is omitted altogether. They are continued on this ration until a few weeks before eggs are wanted, when they are given a mash consisting of 4 parts corn chop, 2 parts bran, 2 parts middlings, 1 part meat scrap, 3 per cent sand, equal parts of either boiled or finely pulped vegetables, and of cut clover as much as they will consume. The mixed grain is also continued.

Changes from one ration to another are made gradually, and rations are varied according to conditions.

GEESE

Geese, like ducks, require a large proportion of roughage in the ration. This is best supplied in winter by the use of alfalfa or clover hay and roots, and in summer by grass. Given the range of a good pasture, a flock of geese require little else unless it is desired to force rapid growth.

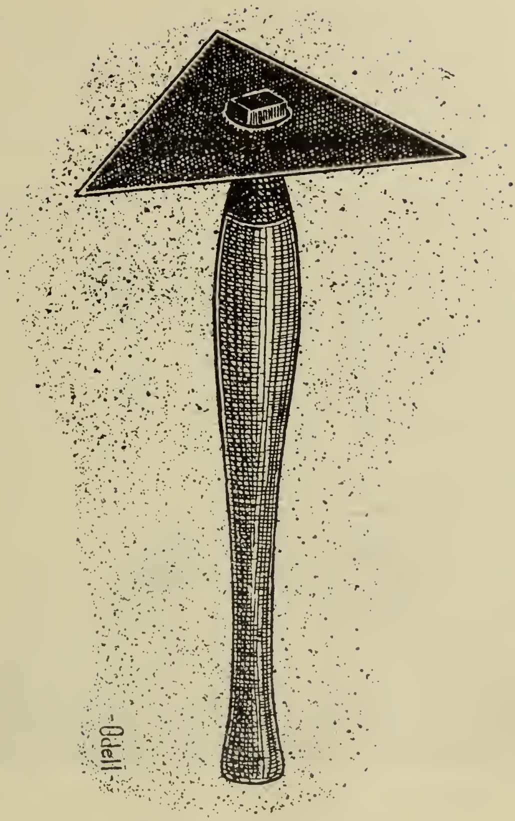

Fig. 9.—Convenient Tool—A scraper similar to that shown in the illustration will be found to be very convenient for cleaning out troughs and doing similar work.

Goslings.—Goslings require warmth and rest the first day, and it is advisable to leave them undisturbed. On the second day they should be placed where they will have free access to a plot of tender grass, otherwise they should be supplied with all the succulent green feed they will eat, together with mash fed them three times a day. The feeds recommended for ducklings are equally suitable for goslings. If it is intended to market the goslings as green geese, it is advisable to feed them mash heavily from the start. If they are intended for stock purposes, it is better, as soon as the goslings get strength enough, that they be allowed freedom to range on the pasture lands, where they will pick up most of their feed, requiring only a light feed of mash in the morning and grain at night.

Fattening.—At six or seven weeks of age, goslings that have been forced from the very start are put on a ration similar to the one recommended for fattening ducks, and should be ready to market at about 12 weeks of age.

Where geese have been kept on pasture all summer, they are penned in the fall and fed heavily on mash feed composed of whatever grains are most available (corn being in especial favour for this purpose), and an occasional feed of whole grain to whet the appetite.

The fattening period usually lasts from three to four weeks.

Stock Geese.—After the breeding season the geese on range may subsist practically on the pasturage. If the grass gets short or dried up, it may be supplemented with mash or green feed, but so long as there is good pasturage no other feed is necessary.

During the winter, the breeders should be fed all the clover or alfalfa hay and roots they will eat, but grain should be fed sparingly (just a light feed morning and night), dependence being placed largely on the coarse grains like oats and barley, only enough wheat and corn being allowed to add variety to the ration. As laying time approaches, a light mash may be added, and when in full lay, the mash feed may be increased.

FIG. 10.—A Pair of Breeders. Canada (Wild) Geese at the Central Experimental Farm.

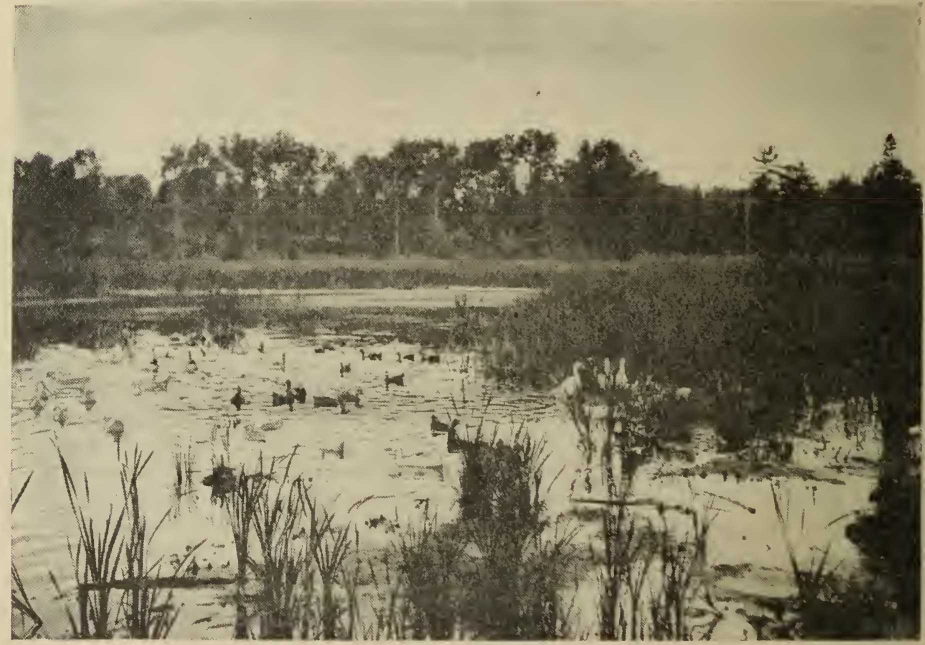

FIG. 11.—Stock Ducks on Range at the Central Experimental Farm. An ideal place to raise the breeders.

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